Technology on the farm

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Changing Technology and Employment in Agriculture

By

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FOREWORD

This report appraises the effect of technological changes on employment in agriculture since 1909. In making this appraisal it sums up 12 monographs published by the Work Projects Administration National Research Project and others still in preliminary form. These studies were conducted as one section of the research program of the WPA National Research Project on Reemployment Opportunities and Recent Changes in Industrial Techniques, directed by David Weintraub of the WPA research staff. The present report contains considerable additional material and devotes more attention than the monographs to the consequences of these changes for the Nation and for the farm population.

In conducting the agricultural studies, three lines of approach were followed, and the results are integrated in this volume. The first involved a study of the changes in total farm employment, farm population, size of the aggregate farm enterprise, and volume of agricultural production.[1]

Materials on farm employment, size of enterprise, and production were furnished largely by the United States Department of Agriculture. A number of persons in the Bureau of Agricultural Economics gave valuable advice. Members of the then Division of Crop and Livestock Estimates supervised the summarization and analysis of unpublished material from the files. These, with data from the Census and other sources, provided a basis for series of indices not only of total production and employment, but also of annual production per worker. These series permitted the measurement of over-all changes which were later explained in detail from studies of farm operation.

Developments in agricultural technology formed the second section of the study. Technologists in the fields of agronomy, horticulture, animal husbandry, and agricultural engineering spent more than a year in bringing together information on the newer technology and interpreting its significance for agricultural employment.[2]

The third section of the work consisted in preparing estimates of the changes in labor requirements per unit of product and per acre of land or per head of livestock for leading farm enterprises. To do this it was necessary first to bring together the widely scattered data on farm-labor requirements by operations and enterprises which had been collected in the course of the many farm-management studies since 1909. This involved an examination of about 1,500 bulletins and other publications.[3] There were many gaps in the published data, and relatively few studies of labor requirements had been made in recent years. Consequently, a field survey of approxi-

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[1] Two reports from this branch of the study have been issued: Report No. A–6, *Trends in Size and Production of the Aggregate Farm Enterprise, 1909–36,* by Raymond G. Bressler, Jr., and John A. Hopkins; Report No. A–8, *Trends in Employment in Agriculture, 1909–36,* by Eldon E. Shaw and John A. Hopkins.

A preliminary report, *Trends in Farm Population in the United States, 1909–36,* was prepared by Madeline Jaffe.

[2] This group consisted of Lloyd E. Arnold, Agronomist; A. A. Lewis, Animal Husbandman; H. E. Knowlton, Horticulturist; and E. G. McKibben, Agricultural Engineer. This section was under the supervision of R. L. Horne.

[3] The results were summarized in Report No. A–3, *Selected References on Practices and Use of Labor on Farms,* by W. A. Newman and L. K. Macy.

mately 4,300 farms in 58 areas (usually of one county each) was made to fill these gaps and to determine present labor requirements for comparison with earlier studies conducted in the same areas.[4]

Combined results of the field survey and the study of technological developments led to the preparation of six monographs on changes in technology and labor requirements of principal crops. As mechanization was found to be the strongest single influence on farm-labor requirements, three monographs were issued on this subject. Finally, a series of preliminary studies was prepared on changes in methods of livestock production, insofar as these have affected labor requirements either directly or through economy of feed utilization.[5]

This report is thus a synthesis of a rather involved and complex study which, in turn, has drawn heavily from related studies conducted by many American research workers in technology and economics. Even these numerous studies taken together, however, cannot be regarded as complete and self-contained. Evolution of modern farm machinery depends largely on developments in engineering and metallurgy. Improved spray materials and fertilizers are derivatives of the same chemical discoveries that have given us modern plastics and invaluable drugs, while geological discoveries that led to an abundant supply of petroleum fuels for farm tractors have been of consequence also in causing the shift of traffic from railroad to highway. Thus the technological changes which have transformed agriculture stem from common roots with those that have affected urban life no less profoundly, partly as a result of basic scientific discoveries and partly as a result of thousands of ingenious modifications in everyday practice.

It is hoped that this report may contribute in some measure to an understanding of the general processes of technological change and of its consequences in the recent past, particularly as it affects agriculture. To accomplish this purpose it was necessary in the body of the report to describe the principal technological changes and to relate their effects to farm employment in considerable detail. The first two and the last two chapters, however, bring out the more important relationships between these and other phases of our economic organization.

JOHN A. HOPKINS,
Economist in Charge, Studies of Changing Techniques and Employment in Agriculture (National Research Project).

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[4] The survey was conducted under the supervision of George A. Sallee and the principal persons engaged in collecting or analyzing the data were L. K. Macy, R. E. Elwood, R. H. Barrett, W. C. Holley, J. C. Schilletter, and D. C. Schmutz.

[5] The following reports have been published on Changes in Technology and Labor Requirements in Crop Production:

Report No. A–1, *Sugar Beets,* by L. K. Macy, L. E. Arnold, E. G. McKibben, and E. J. Stone.
Report No. A–4, *Potatoes,* by H. E. Knowlton, R. B. Elwood, and E. G. McKibben.
Report No. A–5, *Corn,* by L. K. Macy, L. E. Arnold, and E. G. McKibben.
Report No. A–7, *Cotton,* by W. C. Holley, and L. E. Arnold.
Report No. A–10, *Wheat and Oats,* by R. B. Elwood, L. E. Arnold, D. C. Schmutz, and E. G. McKibben.
Report No. A–12, *Vegetables,* by J. C. Schilletter, R. B. Elwood, and H. E. Knowlton.

Reports on Changes in Farm Power and Equipment:

Report No. A–2, *Mechanical Cotton Picker,* by R. L. Horne and E. G. McKibben.
Report No. A–9, *Tractors, Trucks, and Automobiles,* by E. G. McKibben, and R. A. Griffin.
Report No. A–11, *Field Implements,* by E. G. McKibben, J. A. Hopkins, and R. A. Griffin.

Preliminary studies prepared on Changes in Technology and Labor Requirements in Livestock Production:

Dairying, by R. B. Elwood, A. A. Lewis, and R. A. Struble.
Poultry Production, by R. B. Elwood, and A. A. Lewis.

Studies on technological changes in *Swine Production,* and in *Beef Cattle Production* were also prepared by Mr. Lewis and have been utilized in this report.

CHAPTER I. INTRODUCTION

In 1910 an estimated 30.9 million persons lived on farms in the United States (table 1).[1] By 1930 this number had declined to 29.6 million, and the total population of the country had increased from 92 to 123 million. Whereas one farm family in 1910 produced the food and textile raw materials needed by itself and two other families, in 1930 a farm family produced such commodities for itself and three other families.

TABLE 1.—*Population and land in farms, 1850–1935*

Item	Unit	1935	1930	1925	1920	1910
Population, total [1]	Thousands	127,152	122,775		105,711	91,972
Rural	do		53,820		51,406	49,806
Percent of total	Percent		43.8		48.6	54.2
Farm [2]	Thousands	30,396	29,554	30,205	30,536	30,866
Percent of total	Percent	23.9	24.1		28.9	33.6
Number of farms [3]	Thousands	6,812	6,289	6,372	6,448	6,362
Number of farms exclusive of incidental farms [4]	do	6,524	6,230	6,188	6,231	6,148
Approximate land area of United States [3]	Mil. acres	1,903	1,903	1,903	1,903	1,903
All land in farms [3]	do	1,055	987	924	956	879
Percentage in farms [3]	Percent	55.4	51.8	48.6	50.2	46.2
Average acres per farm [3]	Acres	155	157	145	148	138
Cropland harvested [5]	Mil. acres	296	359	345	349	311
Value of farms, land, and buildings, 1926 dollars [6]	Mil. dollars	41,074	55,674	47,795	42,951	49,433

Item	Unit	1900	1890	1880	1870	1860	1850
Population, total [1]	Thousands	75,995	62,948	50,156	38,558	31,443	23,192
Rural	do	45,614	40,649	35,798			
Percent of total	Percent	60.0	64.6	71.4			
Farm [2]	Thousands						
Percent of total	Percent						
Number of farms [3]	Thousands	5,737	4,565	4,009	2,660	2,044	1,449
Number of farms exclusive of incidental farms [4]	do						
Approximate land area of United States [3]	Mil. acres	1,903	1,903	1,903	1,903	1,903	1,884
All land in farms [3]	do	839	623	536	408	407	294
Percentage in farms [3]	Percent	44.1	32.7	28.2	21.4	21.4	15.6
Average acres per farm [3]	Acres	146	136	134	153	199	203
Cropland harvested [5]	Mil. acres	283	220	166			
Value of farms, land, and buildings, 1926 dollars [6]	Mil. dollars	29,617	23,628	14,843	8,074	10,465	5,690

[1] Figures for 1930 and earlier years from *Fifteenth Census of the United States* vol. IV, ch. I, table 4, p. 39; figures for 1935 from *Census of Agriculture, 1935*, vol. III, ch. IV, table 1, p. 142. Statistics for 1935 and 1920 relate to January 1; for 1930 to April 1; for 1910 to April 15; and for earlier years to June 1.

[2] Estimates prepared by Madeline Jaffe.

[3] *Census of Agriculture, 1935*, vol. III, ch. I, table 1, p. 18.

[4] Eldon E. Shaw, and John A. Hopkins, WPA N. R. P. Report No. A.-8, *Trends in Employment in Agriculture, 1909-36*, appendix B.

[5] Before 1924 the total acreage of crops for which figures are available, except for 1919 when 14,502,932 acres of corn for forage were excluded (as most of this was probably duplicated in the acreage of corn harvested as grain) and 55,180 acres in nurseries, greenhouses, and flowers. Acreage in crops refers to the year preceding that in which the census was taken. *Census of Agriculture, 1935*, vol. III, ch. I, table 1, p. 18.

[6] Value of land and buildings from *Census of Agriculture, 1935*, vol. III, ch. I, table 1, p. 18, divided by Bureau of Labor Statistics Index of Wholesale Commodity Prices on base 1926=100.

[1] Estimates prepared by Madeline Jaffe for the National Research Project. Agricultural enterprises providing only incidental employment are excluded from the classifications of "farms" in this report. Thus places classified by the Census as farms but whose operators worked elsewhere 250 or more days per year were not counted, nor was the population living on them considered here as farm population.

This shift has profoundly influenced our whole national economy. It has meant that a larger fraction of the working population is available to produce goods or to render services beyond the satisfaction of physical needs, and to that extent it has provided a basis for a higher standard of living, whether advantage is taken of the opportunity or not. The process by which the implied increase in productivity has occurred is consequently a matter of national interest, and the direction of its present trend is a question of great economic and social importance.

What determines the amount of employment on farms? To answer this question the size of the population and the existing farm technology must be considered. The greater part of farm production consists of food. Next come cotton, wool, and tobacco, for each of which the per capita demand is relatively inelastic. Employment on cotton and tobacco is partly dependent on demands abroad. On the other hand, from 10 percent to 30 percent of the wool used in the United States in recent years has been imported, so that its value, and to some extent its production, depends on our tariff policy. With these exceptions, the volume of agricultural production and, therefore, the amount of farm employment depend on the two factors of size of population and farm technology.

With a given population, such employment declines as labor efficiency on farms is increased. Under a given technology, employment on farms tends to increase along with population. Because the amount of good farm land is limited, it can be expected that the need for workers will outstrip the number of persons to be fed and clothed because of the operation of the principle of diminishing returns.

TABLE 2.—*Gross income and income per farm by selected periods 1910–1935* [1]

Item	1910–13	1917–21	1922–26	1927–31	1932–35
	Mil. dol.	*Mil. dol.*	*Mil. dol.*	*Mil. dol.*	*Mil. dol.*
Gross income	6,691	13,472	11,154	10,344	6,882
Selected expenditures:					
Feed, fertilizer, etc.[2]	828	2,205	2,062	2,209	1,353
Taxes and interest[3]	427	812	1,080	1,110	864
Gross income less feed, fertilizer, taxes, etc.	5,439	10,455	8,012	7,025	4,665
Gross income less feed, fertilizer, taxes, etc. per farm:[4]	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
In current dollars	881	1,677	1,295	1,132	719
In 1910–14 dollars[5]	881	897	887	870	691
Wages for hired labor, including board, total in current dollars	*Mil. dol.* 691	*Mil. dol.* 1,224	*Mil. dol.* 1,087	*Mil. dol.* 1,059	*Mil. dol.* 472
Gross income per farm, less feed, fertilizer, taxes, interest and hired labor, 1910–14 dollars	*Dollars* 769	*Dollars* 792	*Dollars* 766	*Dollars* 739	*Dollars* 621

[1] Data on income and expenditures from *Agricultural Statistics, 1938*, p. 434.
[2] Feed, fertilizer, ginning, purchase of farm implements including autos and trucks, operation of autos, trucks, and tractors.
[3] Taxes on farm real estate and interest on farm mortgages.
[4] Total divided by average number of farms for years indicated, from WPA N. R. P. Report No. A-8, *Trends in Employment in Agriculture, 1909–36*, by E. E. Shaw and J. A. Hopkins, p. 113.
[5] Current dollars divided by U. S. Bureau of Labor Statistics Index of Wholesale Commodity Prices (1910–14=100).

The reduction in the relative number of workers required to provide our farm products since 1909 suggests the extent to which the technology of agriculture has improved. This improvement will be examined in detail in later chapters. Before going into that ques-

tion, however, it may not be amiss to ask what have been the consequences of improved methods on the farm population itself and on the Nation at large. Have the farmer and his family benefited from his greater labor efficiency? Has he received a larger income? Have farm incomes increased in step with nonfarm incomes? Has the farmer gained from more leisure? Has he obtained greater economic security? How has the farm population fared in comparison with other groups?

HAS TECHNOLOGY RAISED FARM INCOME?

After correction for the variation in the buying power of the dollar, there was little difference in gross farm income from 1910–13 to 1927–31. From 1927–31 to 1932–35, however, gross farm income declined about 20 percent even after such correction, although these figures do not give an exact indication of the trends (table 2). Data were not available on all elements of expense and various farming areas and groups have fared differently. It will be shown that some areas were able to take advantage of various technological improvements and to profit thereby, while others were unable to utilize the larger equipment or the improved techniques and have been placed at a disadvantage.

Although a large part of the farmer's income is from the work which he does himself, this labor income is indistinguishable from his returns for management and those for the use of his own land and capital. Only the hired workers' earnings can be compared directly with those of urban laborers, and even these comparisons are likely to be misleading, because hours of work are different as between city and farm; the buying power of the dollar is higher in the country; and the farm worker may receive some perquisites from his employer which are difficult to evaluate satisfactorily. Nevertheless, it is significant that from 1921 to 1930 the average monthly wage rate of farm hired workers, without board, was $46.72, and the average rate, without board, for daily workers was $2.36 per day.[2]

As against this, the average rate of pay for factory workers was $25.47 per week.[3] Data from the same sources permit comparisons with the years since the beginning of the depression (table 3).

TABLE 3.—*Estimated factory earnings and farm wage rates, specified periods*

Period	Estimated weekly factory earnings	Monthly farm wage without board
	Dollars	*Dollars*
1921–30	25.47	46.72
1931–34	19.32	28.34
1935–37	22.69	32.12

It will be noted that farm wages were decidedly lower than factory wages, and that they were relatively lower at the end of the period than at the beginning. In the period 1921–30 a farm hired hand

[2] *Agricultural Statistics, 1938* (U. S. Dept. Agr.), p. 450.

[3] Estimated from per capita weekly earnings in manufacturing establishments other than railroad repair shops from 1929 to 1937, and from indexes of factory employment, and indexes of factory payrolls from 1920 to 1937. Data furnished by U. S. Bureau of Labor Statistics.

received per month 1.8 times as much as the weekly earnings of the factory worker. In the period 1931–34, if each were employed full time, the monthly farm rate was 1.5 times as much as the weekly factory rate; and in 1935–37 the farm rate was only 1.4 times as great.

Relative earnings of labor on farms differ widely as between various parts of the country, as may be seen from table 4.

TABLE 4.—*Relative earnings of labor on farms, by areas, October 1, 1938*

Area	Earnings per month	Earnings per day	Area	Earnings per month	Earnings per day
	Dollars	*Dollars*		*Dollars*	*Dollars*
New England	55.13	2.58	East South Central	22.66	1.03
Middle Atlantic	45.83	2.39	West South Central	27.86	1.24
East North Central	41.68	2.16	Mountain	52.29	2.33
West North Central	39.20	2.12	Pacific	62.05	2.71
South Atlantic	24.40	1.16			

Monthly wages in the South averaged below $30 as compared with more than $50 in the New England, Mountain, and Pacific Divisions. These figures, however, overstate the differences in real wages, as the worker's dollar buys more in the South.

During the depression years of the early 1930's, a comparison of wage rates for persons who still had employment in cities with earnings of farm workers gave no indication of the relative advantage of all groups in either of the two industrial areas. In urban areas from 10 to 12 million persons were out of work, and on farms hired hands were having a hard time to find employment. But farmers and members of their families were able at least to earn a living, if they could keep possession of their farms. Consequently, many farmers' sons stayed at home with their parents instead of migrating to cities, and others returned from the city after losing their jobs, so there was a tendency for hired workers to be laid off while more of the work was done by members of the farm family.

If hired workers in agriculture have received relatively small remuneration, other farm groups have fared only a little better. Approximately one-fourth of the population is dependent on agriculture. Estimates of total national income and the income of agriculture, in millions of dollars, for the years since 1929, are shown in table 5.[4]

TABLE 5.—*Total national income and income of agriculture, specified periods*

	1929–30	1931–34	1935–37
	Mil. dol.	*Mil. dol.*	*Mil. dol.*
Total national income	74,715	46,536	62,823
Agriculture	6,472	3,463	5,764
	Percent	*Percent*	*Percent*
Percent to agriculture	8.7	7.4	9.2

Thus, the quarter of the population engaged in agriculture in 1929–30 received only 8.7 percent of the national income. Even with the

[4] Source: *Income in the United States, 1929–37* (Bureau of Foreign and Domestic Commerce, November 1938), table 1.

efforts of the Federal Government to increase agricultural income, it amounted to only 9.2 percent in the years 1935–37.

If there was no gain to the farm people in the form of increased income, it is possible that there was a gain in increased leisure. Possibly the same income was gained at the cost of fewer working hours a day or a year. Further, it is possible that the number of workers per farm—including family and hired workers—has changed so that the income received is divided up among a different number of workers than in the earlier years covered by this report. Thus, it will be necessary to examine the figures on numbers of persons employed in agriculture since 1909, which marks the beginning of the period under consideration.

FARM EMPLOYMENT AFFECTED BY CHANGES IN SIZE AND SCOPE OF THE FARM ENTERPRISE

Given the amount of farm produce to be provided, the number of needed farm workers depends on the effectiveness with which this labor is used. As long as population continues to grow it will be necessary to wrest increasing amounts of produce from an almost fixed area of land. To the extent that such intensification is necessary, the principle of diminishing returns may be expected to operate and to require greater amounts of labor per unit of product. During the period to be studied, however, diminished returns have been offset, historically speaking, by improvements in methods. Consequently this report is not concerned particularly with this principle but chief attention will be given to the changes in methods which have affected agricultural employment since 1909.

Before the relative importance of population growth and of changes in agricultural technology on farm employment can be finally appraised, the question: What has occurred in the habits of the consumer? should be considered. Have his tastes turned to farm products which require more labor per unit of food value? Or has he, perhaps, developed a fondness for synthetic products which can be produced elsewhere than on the farm? These questions will be examined briefly in chapter IX.

Another influence affecting the aggregate size of the farm enterprise and the total volume of employment is the trend in foreign trade. A large part of some crops, such as cotton and wheat, have been sold abroad and their production has provided employment for a large number of farm workers. To a great extent, however, production for export affects the place where the employment occurs rather than the total amount of employment. That is, foreign rubber or tin might be paid for by means of farm labor spent in raising cotton, or it might be paid for by industrial labor spent in producing automobiles. In any event, trends of agricultural exports and foreign demand must be considered along with trends in domestic demand.

It is important to distinguish between changes in size of the farm enterprise and changes in volume of farm production. The index of size of the aggregate farm enterprise increased only about half as much as a similar index of the physical volume of agricultural production. The problem arises, therefore, of explaining, not only why

the volume of agricultural production increased by an amount different from that in size of the farm enterprise, but also how both of these could increase while the volume of employment actually declined.

SHIFTING OF OPERATIONS FROM FARMS TO URBAN AREAS

During the last quarter century many operations in agricultural production have been shifted, at least partly, from farms to urban areas. Many of the operations of processing and marketing of farm products have been taken over by specialized agencies, usually located in towns or cities. The growth of cooperative livestock selling agencies, cooperative grain elevators, and cooperative agencies for packing and shipping fruits and vegetables may be mentioned. So may the shift in manufacture of butter and of livestock slaughtering, both of which functions have come to be performed very largely by commercial agencies rather than on farms. Much of the hauling formerly done by farmers themselves is now done by commercial truckers. This is true of the hauling of livestock, grains, and of fluid milk, which in many sections is collected at or near the farm by milk trucks operated cooperatively or commercially.

The greatest shift of labor from farms to cities and towns is related to the displacement of horses by mechanical power units which is discussed in chapter V. This means a shifting of the production of power units from the production of colts on farms to the nonfarm manufacture in cities of farm tractors and automobiles, as well as fuel, lubricants, tires, and repair parts for them. Farm labor and land previously used to grow feed for horses, now displaced, have been shifted to production of other crops, many of them intended for human consumption rather than for feed. This explains a good part of the increase in consumable products both per worker and per unit of the farm plant, and enables agriculture to support a larger population without a proportionate increase in farm acreage.

Aside from this shifting of function from farm to city, however, the pronounced growth in production per worker must be examined in order to appraise correctly the trends in farm employment.

INFLUENCES MAKING FOR INCREASED PRODUCTION PER WORKER

Continuous adoption of various labor-saving methods or appliances has been stimulated by the farmer's desire to reduce expenses and increase his net income. A common means of saving labor is by increasing the number and size of mechanical appliances. There are also changes in ways of doing things on farms aside from changes in the implements used. One illustration is found in the discontinuance of unnecessary crop cultivation. Formerly it was considered good practice to cultivate frequently whether or not there were weeds to be destroyed. Changes in technique, however, may be designed either to reduce the labor per acre or to increase the yield. In either case they usually reduce the hours required per unit of product. Ten of the more important types of changes are listed below:

(1) Changes in the internal organization of the farm may, to some extent, bring changes in labor productivity. For example, since agriculture is a highly seasonal industry, changes in the selection of farm enterprises may result in more complete year-round utilization of labor and may thus increase the output per worker.

(2) Changes in the proportions between the factors of production, as the use of more capital per man, or the application of less labor per acre of land, may affect production per worker. This is a corollary of the principle of diminishing returns. The question of whether the amount of capital per farm has changed since 1909 will be examined in chapter IV.

(3) During a period of inventive activity, the form of capital is sure to change as well as the total amount employed. Consequently, improvements in type and design of implements used on farms will be considered in chapter V.

(4) Closely related to the form of capital is the application of more power per worker. Adoption of the tractor has been most prominent in this respect.

(5) More effective land utilization increases production per worker. One form of this is found in more effective means of conserving the productive power of the land by preventing erosion and maintaining soil fertility.

(6) A more positive means of increasing output is by heavier application of fertilizer which has occurred in some areas since 1909.

(7) Control of plant and livestock diseases and pests can augment greatly the amount of crop and livestock products that actually get to market. Such control increases output per acre or per animal and per worker, even though it requires the application of some labor.

(8) Agricultural production has undoubtedly been increased by the development of more productive varieties of crops, thus increasing directly the output per unit of labor.

(9) Strains of livestock as well as crop varieties have been improved by more scientific methods of breeding. This has led to an increased output for each pound of feed used as well as for each cow, sow, or hen.

(10) Discoveries related to animal nutrition have been a factor contributing to labor saving. The discovery of vitamins, the proper balancing of rations, and the provision of needed mineral foods may increase production per unit of direct labor on livestock. As with improved animal breeding, such changes may also save labor indirectly. With greater economy of feed use, smaller acreages of crops suffice for the production of a given amount of meat, milk, or eggs, and thus labor is saved in crop as well as in livestock production.

INFLUENCES MAKING FOR DECREASED PRODUCTION PER WORKER

Not all the major influences affecting agriculture since 1909 have made for greater productivity per worker; partly offsetting the influences listed are some that have tended to reduce output. Four of the principal ones follow:

(1) In some areas an extension of crop production to less productive lands has taken place. This means a lower yield per acre and may mean smaller production per hour of labor.

(2) As more labor and capital are applied per acre in the older and more intensive regions, the principle of diminishing returns may operate to lower the output per hour of labor. This assumes that the agriculture of the regions concerned was already operating at optimum intensity under existing methods. This principle, historically difficult to observe, may be assumed to be present and operative at any stage of technology.

(3) The most important cause of reduced production per worker in agriculture since 1909 has undoubtedly come from deterioration of the land in certain areas through erosion or depletion of fertility.

(4) New insect pests and diseases have appeared from time to time and old ones have spread to new areas, despite efforts to control them. The cotton boll weevil and the Japanese beetle are examples of new insect pests; losses among dairy cattle from Bang's disease illustrate the spread of livestock disease.

Changes in the agricultural output, either per acre of land or per hour of labor, have thus resulted from a complex of many influences. In most cases it is not possible to separate the effects of the different forces. Improvements in crop varieties have tended to raise yields, but erosion and soil depletion have tended to reduce them. Control measures applied to various diseases and pests have been improved, but they have involved additional labor for spraying or other operations, and new pests have appeared as the old ones have been brought under control. Gross changes in the input of labor into agriculture and gross changes in output may be measured, but it is not possible to separate the results of all of the individual influences. Effects of some of these can be measured with a fair degree of precision, while with others it is a matter of determination either of relative importance or of directional effect.

CHAPTER II. TRENDS IN FARM POPULATION AND EMPLOYMENT

Before discussing specific influences affecting farm employment, the facts concerning its trend during the period 1909–36 should be stated. Further, employment in agriculture affects the size of the rural population and this, in turn, is closely related to the rate of growth of the national population and to some of its characteristics.

TRENDS IN FARM POPULATION

Forty-four percent of the total population of the United States in 1930 lived in rural districts (table 1). The population living on farms was much smaller, and amounted to only 24 percent.[1] Not all persons living on farms, however, were engaged in farming and some persons who were engaged in agriculture did not live on farms.

Number of Persons Dependent on Farm Employment

The estimated number of persons dependent primarily on agricultural employment in April 1930 was 29.6 million (table 6). Ninety percent of these persons lived on farms and 10 percent in nonfarm areas. Of the total, approximately 5.2 million were farm laborers and their dependents.

Table 6.—*Estimated population dependent on agricultural employment, by place of residence and tenure, United States, 1930* [1]

Item	Total persons	Owners and dependents	Tenants and dependents	Croppers and dependents	Managers and dependents	Laborers and dependents
Total population dependent on agriculture	*Thousands* 29,587	*Thousands* 13,363	*Thousands* 10,732	*Thousands* 3,711	*Thousands* 269	*Thousands* 5,223
Rural persons	28,423	13,057	10,486	----------	228	4,652
Farm	26,307	12,632	10,145	----------	174	3,356
Nonfarm	2,116	425	341	----------	54	1,296
Urban persons	1,164	306	246	----------	41	571
Farm	285	----------	----------	----------	----------	----------
Nonfarm	879	----------	----------	----------	----------	----------

[1] In regard to methods used in computing, *see* Appendix A, filed in the library of the Bureau of Agricultural Economics.

Besides this population there were also persons dependent on agricultural employment to a minor degree as shown in table 7. That is to say 540,000 persons classified by the census as farm operators reported that they worked off their farms 150 or more days in 1929. Eighty-six percent of these persons reported that such employment was in nonagricultural occupations. These operators and their de-

[1] Most of the estimates of farm population were prepared by Madeline Jaffe for the National Research Project.

pendents together numbered 2 million persons. Thus, in 1930, the total number of persons dependent on agriculture, either primarily or to a minor degree, was 31.6 million.

TABLE 7.—*Farm operators working off the farm and their dependents, United States, 1929* [1]

Days worked off farm	Operators	Operators and dependents
	Thousands	*Thousands*
Working off the farm less than 150 days	1,363	6,093
Working off the farm 150 or more days	540	2,380
Working off the farm 150 or more days and dependent mainly on nonagricultural employment	[2] 463	2,037

[1] In regard to methods used, *see* Appendix A filed in the library of the Bureau of Agricultural Economics.
[2] Operators who worked off their farms 150 or more days and who also reported that such employment was nonagricultural.

On the other hand, 1.4 million farm operators worked off their farms to some extent, but fewer than 150 days in the year. They and their dependents numbered 6.1 millions. Thus it is not possible to say that a certain definite number of persons is dependent on employment in agriculture as the same persons are often employed partly in one industry and partly in another. Of the 6.3 million classified in the 1930 Census as farm operators 1.9 million also worked elsewhere than on their farms. Or viewed from the other side, we might say that according to the census, nearly a half-million who spent most of their time in nonagricultural occupations also operated farms.

The Farm as a Seedbed of Population

Besides providing employment for a large proportion of the population, agriculture plays another role which cannot be overlooked in any consideration of national trends of employment and unemployment. The farm has always served as a seedbed for population, and in these decades, when cities are not maintaining their own population, the farming community becomes doubly important. The rural natural increase rate in 1920 was estimated at 18.3 per thousand persons on farms. This figure was twice that of the urban population. By 1932 rates of both population groups had declined, but the rate of increase on the farm of 13.5 was still more than double that of urban areas.

The high rate of natural increase plus the increase in production per worker without a corresponding increase in the demand for farm products resulted in a movement of population from farms to cities, the size of which is seen in table 8.

TABLE 8.—*Natural increase in farm population and movement to cities, specified periods*

Period	Natural increase	Net movement from farms
	Thousands	*Thousands*
1920–24	2,860	3,191
1925–29	2,149	2,800
1930–34	1,961	1,119

The size of the farm-to-city movement, however, has varied from year to year, depending on business activity and the amount of employment available in cities.

During the decade 1920–29, therefore, the natural increase on farms amounted to approximately 5 million persons, while the net movement away from farms was 6 millions. This resulted in a shrinkage in the farm population of about 1 million. During the next 5 years the natural increase was just under 2 millions, while, largely because of the depression, the movement away from farms was only 1.1 million. Meanwhile, agricultural methods had continued to improve, and that portion of the population which would have migrated to cities in more normal years was backed up on farms awaiting opportunity for employment elsewhere. The number of persons seeking industrial work may be expected to continue large for some years in the future. With a declining rate of farm increase and a reduction in proportion of total population living on farms, however, the farm-to-city movement is likely to become smaller and smaller as time goes on. Agriculture will thus become less important as a source of labor for other industries, and will provide a smaller increase for the country as a whole.

TRENDS OF EMPLOYMENT IN AGRICULTURE

In the amount of employment provided, agriculture is second among the principal census groups of occupations. Approximately 10.5 million persons had farm work on April 1, 1930, according to the census (table 9). This amounted to 21.4 percent of all the gainfully occupied persons of the country. Manufacturing and mechanical industries surpassed agriculture with 14.1 million persons. The relative importance of these two occupational divisions has been reversed since 1910. In that year, agriculture provided employment for 12.4[2] million persons, compared with 10.7 million in the manufacturing and mechanical industries. Each of these industries includes many different types of work, although manufacturing covers the wider field.

Agriculture has declined in relative importance, but the proportion of persons and the absolute numbers employed in transportation, trade, public service, professional service, and clerical occupations have risen. Greater productivity per worker in agriculture has released an increasing proportion to those occupations which serve the more elastic demands for manufactured goods, trade, and professional services.

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[2] It should be pointed out that, in 1910, the instructions given to census enumerators apparently resulted in counting too many women and children as engaged in agriculture. The effect is seen in the census figures of 1.8 million women reported as engaged in agriculture as compared with 1.1 million in 1920 and 0.9 million in 1930.

TABLE 9.—*Gainful workers 10 years old and over, by selected occupational divisions, United States, 1910, 1920, 1930* [1]

Selected occupational divisions	Percentage distribution (total)	Number		
		Total	Male	Female
	Apr. 1, 1930	*Percent*	*Thousands*	*Thousands*	*Thousands*
All occupations		100.0	48,830	38,078	10,752
Agriculture		21.4	10,472	9,562	910
Manufacturing		28.9	14,110	12,224	1,886
Trade		12.5	6,081	5,119	963
Domestic and personal service		10.1	4,952	1,772	3,180
Clerical occupations		8.2	4,025	2,038	1,987
	Jan. 1, 1920				
All occupations		100.0	41,614	33,065	8,549
Agriculture		25.6	10,666	9,583	1,083
Manufacturing		30.8	12,832	10,902	1,930
Trade		10.2	4,258	3,586	672
Domestic and personal service		8.1	3,380	1,193	2,187
Clerical occupations		7.5	3,112	1,690	1,422
	Apr. 15, 1910				
All occupations		100.0	38,167	30,091	8,076
Agriculture		32.5	12,388	10,582	1,806
Manufacturing		27.9	10,657	8,836	1,821
Trade		9.5	3,633	3,160	473
Domestic and personal service		9.8	3,755	1,225	2,530
Clerical occupations		4.5	1,718	1,130	588

[1] *Fifteenth Census of the United States, 1930*, Population, vol. IV, Occupations, p. 6, table 2.

CLASSIFICATION OF AGRICULTURAL WORKERS

Most of the labor performed on American farms is done by the farm operators themselves. The farm, however, is essentially a family enterprise and able members of the farmer's family are likely to be found helping with the farm work.[3] The second main classification includes hired and paid workers. This group is less important numerically than the family workers, and varies more in its composition from season to season and from one phase to another of business fluctuations. Seasonal changes in the composition of the family labor group are found also. A farmer's wife who assists with chores or field work for the equivalent of 2 days a week during the busy season is counted during that season as an unpaid family worker. During the remainder of the year, if she is engaged only in housework or does only a few hours of chores in the course of the week, she is not so counted.

Farmers' sons of school age help with chores and those who are old enough do field work when school is not in session. Consequently, many of these boys are counted among the unpaid family workers from June to August. Older sons may work on the farm the year around. If they are paid, they are counted with the hired rather than the family workers. During slack seasons and depressions, these young men may stay on the farm and help with what work is to be done but receive no regular wages. In this case they become, for the time at least, unpaid family workers rather than hired laborers.

Sharecroppers occupy a status between that of tenants and hired workers, with some of the characteristics of each class. In this report, as well as in census reports, they are classified as family workers. They

[3] It should be noted here that family workers in agriculture do not include persons who are engaged merely in housework. The group is limited to those who are engaged in work connected with agricultural production for at least two days, or their equivalent, during the week for which each estimate is made.

might, with some reason, be classified as hired workers, together with members of their families who help them at farm work.

The 1930 Census showed 776,278 sharecroppers in the Southern States.[4] In the eastern cotton and delta cotton areas, croppers amounted to 28 percent and 34 percent of the reported farm operators, respectively. They were also important in the middle eastern and the western cotton areas, where they comprised 14 percent and 13 percent of the operators. If these percentages are applied to the total number of family workers in the respective areas, it will be found that all workers in the sharecropper group numbered more than a million. If the croppers were shifted to the group of hired workers it would nearly double the size of the latter group in these southern areas, and would reduce the number of family workers by a fourth, as may be seen in table 10.

TABLE 10.—*Distribution of agricultural employment by major farming areas, 1924–29* [1]

Area	Percentage of United States total	Number of persons			Percentage of total	
		Total	Family workers	Hired workers	Hired workers	Hired workers plus croppers[2]
	Percent	*Thousands*	*Thousands*	*Thousands*	*Percent*	*Percent*
United States [3]	100.0	11,362	8,419	2,944	26	35
Corn	11.7	1,325	947	378	28	----------
Eastern dairy	6.8	778	510	268	34	----------
Western dairy	8.3	948	680	268	28	----------
Middle eastern	16.4	1,858	1,469	389	21	34
Eastern cotton	12.8	1,460	1,147	313	21	47
Delta cotton	11.8	1,341	1,116	225	17	47
Western cotton	11.0	1,255	956	299	24	38
Small grain	7.0	798	593	205	26	----------
Range	2.5	288	174	114	40	----------
Northwestern	2.4	271	190	82	30	----------
California [4]	2.9	332	142	190	57	----------

[1] Source: Eldon E. Shaw and John A. Hopkins, *Trends in Employment in Agriculture, 1909–36*, WPA N. R. P. Report No. A–8.

[2] Approximate percentage. Number of workers in croppers' families estimated by multiplying total number of family workers in areas indicated by the percentage which croppers were of total farm operators in 1930, according to Census of Agriculture, 1935, vol. I, State table 1. The numbers of workers so computed were then added to hired workers.

[3] United States total includes six miscellaneous States not included in areas given.

[4] *Fifteenth Census of the United States, 1930*, Population, vol. IV, Occupations by States, State table 4, p. 174.

DISTRIBUTION OF AGRICULTURAL EMPLOYMENT BY AREAS

To promote simplicity in discussion it will frequently be necessary, in this report, to refer to major farming areas of the United States. The general areas used are shown in figure 1. These represent blocks of entire States within which farming methods and conditions can be considered, in general, to be fairly homogeneous.[5]

The average number of persons employed in agriculture from 1924

[4] *Fifteenth Census of the United States, 1930*, Agriculture (U. S. Dept. Commerce, Bureau of Census, 1932), vol. IV, ch. III, table 7, p. 156.

[5] Groups of entire States are used although the farming regions themselves cut across political boundaries. Many of the data which it was desired to study were not available for smaller units. Some could have been broken down into counties, with considerable effort and time. But the division into counties that would have been significant for one purpose, such as an analysis of the corn crop, would not have been appropriate for other

through 1929 was 11.4 million (table 10).[6] Of this number 12 percent was located in the corn area, 8 percent in the western dairy area, 7 percent in the small-grain area and 8 percent in areas farther west. In these areas technological changes have been most rapid since 1909. In the cotton areas, on the other hand, those technological changes which are likely to displace labor have been slow up to this time, and these areas contained 36 percent of the persons in agriculture.

The middle eastern area, with a large number of small and relatively unproductive farms, had 16 percent of the total farm employment and the eastern dairy area had 7 percent. Conditions varied widely within these two areas and some sections made rapid strides while others changed very little.

Seasonal Variation in Farm Employment

Agriculture is subject to wide seasonal swings in employment (fig. 2). A low point is reached in January, and peaks occur in the early summer with crop cultivation and the harvesting of small grains and hay, and later in the fall with the harvesting of corn and cotton. It is generally true also that the seasonal variation is much wider for hired workers than for the farmer or members of his family. Family employment varies from a low of 84 in January to a peak of 115 on June 1, while the employment of hired workers varies from 70 in January to 119 in June with a peak of 122 in October. The summer peak of family employment coincides with the months when school is not in session, although the fall peak, which is most pronounced in the cotton areas, involves keeping some children out of school. For other members of the farm family, the fluctuation in employment is largely a matter of variation in the number of days worked by family members who are on the farm continuously. With the hired workers, on the other hand, the variation is more serious and means either that there is no employment during slack seasons or that they must find work elsewhere.

Each farming region has its own typical seasonal variation and these are partly hidden in the average for the United States as a whole. The corn and dairy areas show the smallest monthly variation, particularly in family employment, whose index, in the corn area, varies only from 95 in January to 106 in July, while in the dairy areas it is from 93 to 110 in the same months. Even in these areas the employment of hired workers fluctuates from about 72 in January to nearly 130 in August.

Greatest effort to reduce labor requirements is made in the peak seasons. This is true both of farmers and of equipment manufacturers, agricultural engineers, and others. Illustrations of the results are seen in the adoption of the combine, which has greatly reduced peak-season labor requirements in the small-grain area, and in the adoption of multiple row cultivating outfits and mechanical corn pickers in the corn area. Until such implements or methods are

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enterprises such as wheat or dairy cattle. In the special studies dealing with individual enterprises, more refined classification of areas, based on county data, will often be used. In such cases the specific areas will be described or shown on accompanying maps. Six States were omitted from the general areas shown in fig. 1. These were Maine, Rhode Island, New Jersey, Delaware, Florida, and Missouri. In each of these States two or more contrasting sets of conditions were found, or else the general system of farming was markedly different from that in the adjacent major area, so that their inclusion would seriously have decreased the homogeneity of the resulting statistics for the major areas.

[6] For more complete data on farm employment see Eldon E. Shaw and John A. Hopkins, *Trends in Employment in Agriculture*, WPA N. R. P. Report No. A–8, November 1938.

perfected, seasonal employment fluctuates widely; this is highly undesirable from the worker's viewpoint. Unfortunately, perhaps, the methods which reduce seasonal fluctuations usually do so by

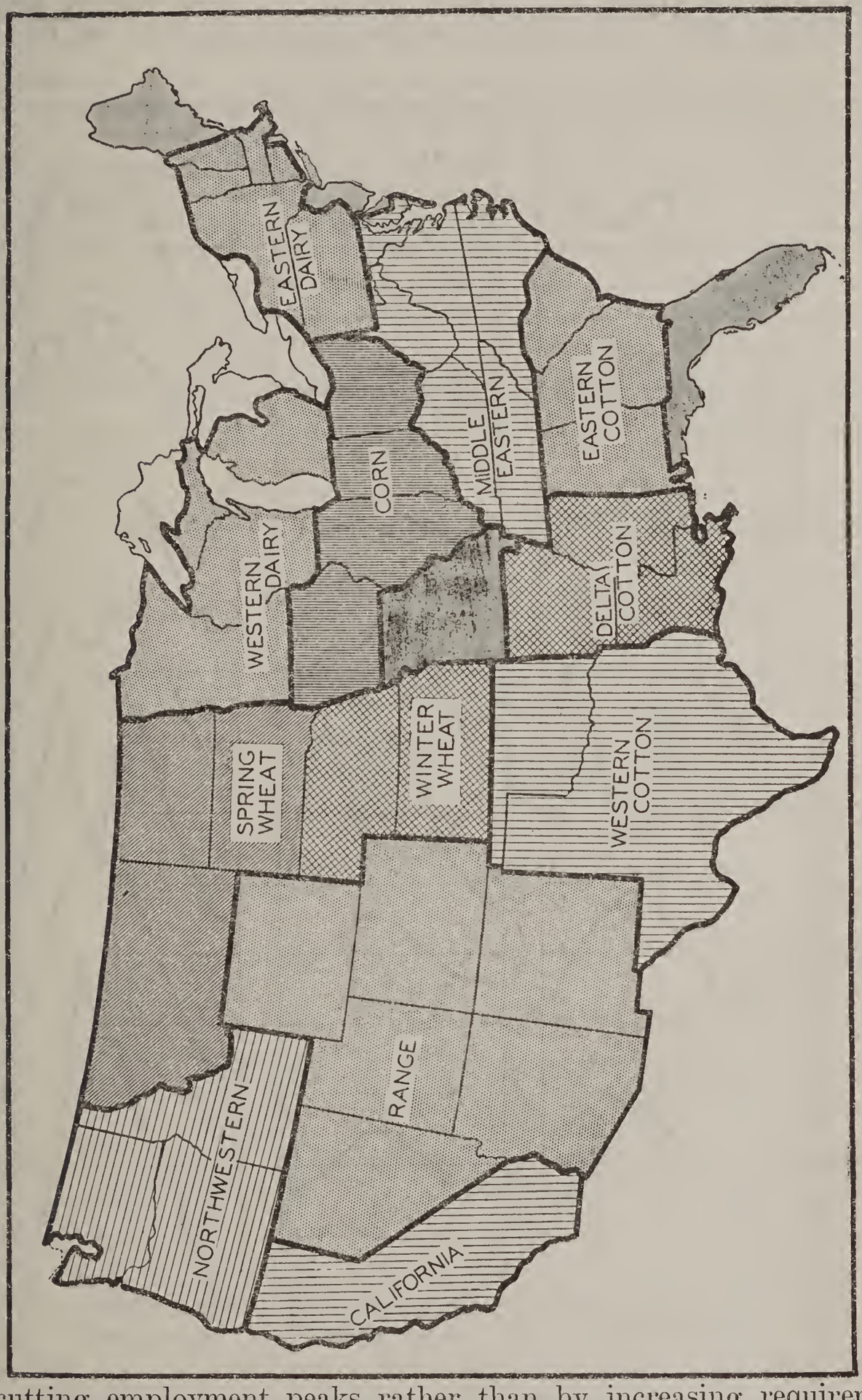

FIGURE 1.—Major farming areas of the United States.

Source: WPA National Research Project.

cutting employment peaks rather than by increasing requirements in slack seasons. Employment is provided more often for slack seasons by shifts in type of farming toward greater diversification, usually towards more livestock production.

Trends of Employment Since 1909

Agricultural employment for the country as a whole declined 13 percent between 1909 and 1939, or from a yearly average of 12.2 to 10.6 millions (table 11). There was only a little change from 1909 through 1916. The sharpest decline occurred during the World

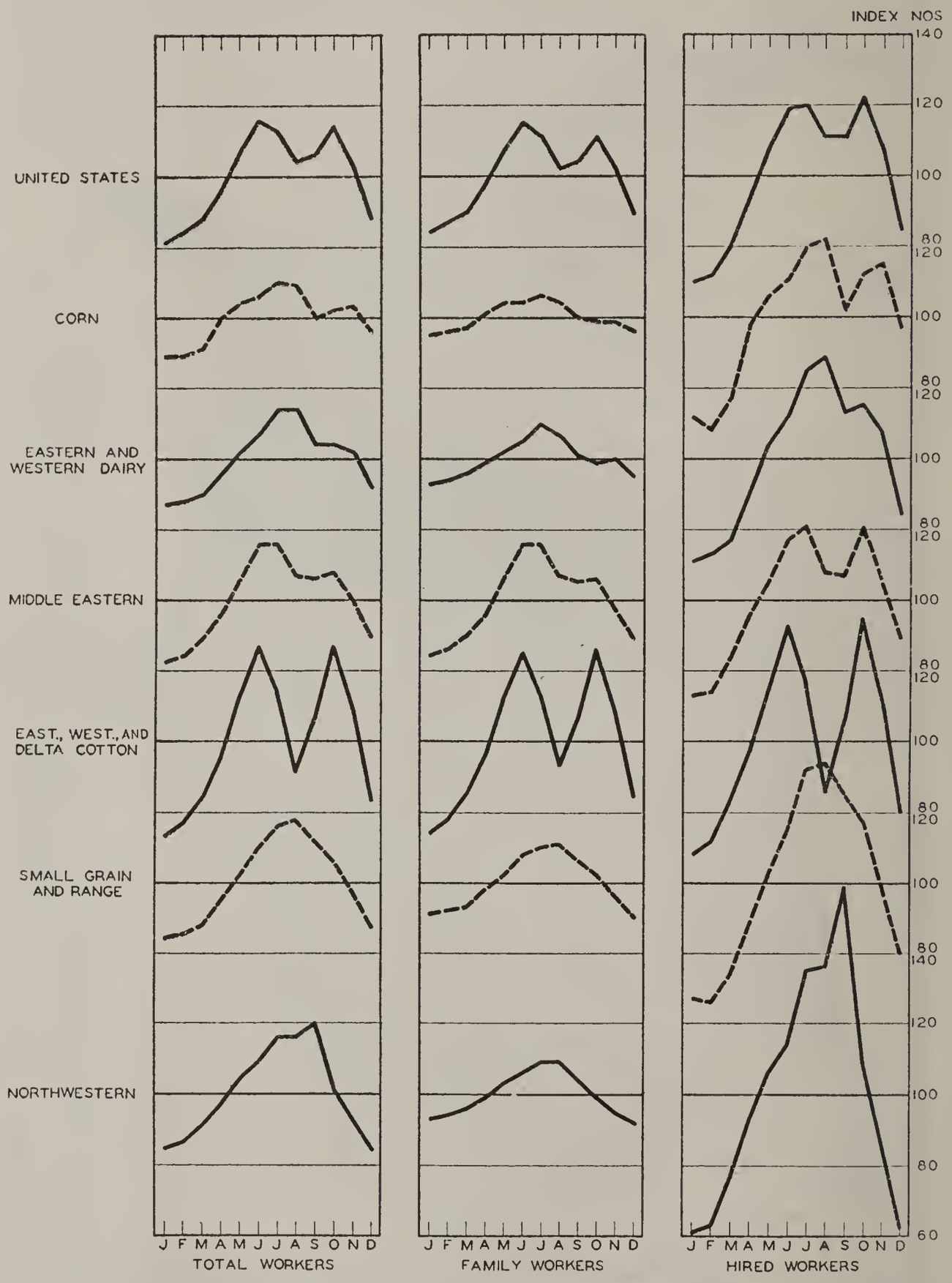

Figure 2.—Seasonal variation in employment in agriculture by areas, 1925–36.

Source: Based on E. E. Shaw and J. A. Hopkins, *Trends in Employment in Agriculture, 1909–36*, WPA N. R. P. Report No. A–8, November 1938, tables 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 21.

War and amounted to some 7 percent or 8 percent. Immediately after this there was a slight recovery and then no further change of consequence until after 1931. With rapidly advancing mechanization, the years 1931–39 saw a new decline of 4 percent, even while unemployed or partly employed population was being "backed up" on farms in certain regions.

Numbers of family workers and of hired workers followed different trends. During the World War years family workers declined 9 percent as against 4 percent for hired workers. During the depression years from 1929 to 1935, on the contrary, the number of hired workers dropped a fifth, while family workers actually increased 4 percent. Part of this shift was related to the change in status of farmers' sons from hired workers to unpaid family workers. But there was also a tendency to hire less labor of any sort while farm operations were unprofitable. The hired workers naturally bore the brunt of the depression. As the family workers were on the farm and required support anyhow, their numbers remained practically the same, unless, indeed, they were actually increased by unemployed sons returning to the farm while the depression was at its worst.

TABLE 11.—*Annual average of number of persons employed in agriculture*[1]

Year	United States	Corn area	Eastern dairy area	Western dairy area	Middle eastern area	Eastern cotton area	Delta cotton area	Western cotton area	Small grain area	Range area	Northwest area
	Thousands	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*
1909	12,209	1,570	1,012	945	2,111	1,750	1,376	1,224	801	240	225
1910	12,146	1,556	1,000	945	2,097	1,739	1,362	1,218	797	244	230
1911	12,042	1,537	986	944	2,068	1,728	1,342	1,208	791	247	233
1912	12,038	1,531	977	942	2,065	1,722	1,340	1,212	793	252	237
1913	12,033	1,525	969	941	2,060	1,717	1,337	1,216	795	257	241
1914	12,000	1,515	959	939	2,050	1,709	1,330	1,217	795	262	244
1915	11,981	1,508	950	937	2,043	1,704	1,325	1,218	796	266	247
1916	12,016	1,506	944	934	2,044	1,707	1,327	1,227	801	271	252
1917	11,789	1,474	926	930	1,996	1,667	1,288	1,201	786	272	254
1918	11,248	1,418	846	917	1,920	1,607	1,242	1,161	764	266	250
1919	11,106	1,380	809	910	1,877	1,570	1,215	1,139	755	262	248
1920	11,362	1,401	837	919	1,918	1,605	1,236	1,173	764	276	257
1921	11,412	1,396	829	925	1,925	1,602	1,250	1,190	768	275	259
1922	11,443	1,370	817	930	1,928	1,594	1,260	1,212	777	285	263
1923	11,385	1,358	807	934	1,912	1,539	1,281	1,220	778	282	263
1924	11,362	1,349	808	946	1,897	1,501	1,278	1,234	781	282	268
1925	11,446	1,356	811	962	1,881	1,474	1,334	1,247	792	285	269
1926	11,534	1,344	799	982	1,885	1,489	1,364	1,278	794	286	273
1927	11,246	1,315	766	942	1,836	1,434	1,310	1,234	807	286	263
1928	11,295	1,291	750	928	1,835	1,456	1,361	1,259	809	287	272
1929	11,289	1,298	732	927	1,816	1,408	1,398	1,280	808	302	282
1930	11,173	1,282	754	915	1,803	1,436	1,340	1,245	800	298	279
1931	11,159	1,255	750	930	1,830	1,405	1,333	1,265	782	297	279
1932	11,069	1,244	740	926	1,841	1,418	1,314	1,214	774	292	282
1933	11,023	1,246	745	923	1,842	1,393	1,345	1,160	769	305	287
1934	10,852	1,205	736	902	1,859	1,375	1,348	1,105	738	302	287
1935	11,172	1,265	747	924	1,951	1,413	1,368	1,158	752	307	289
1936	10,997	1,235	737	922	1,904	1,383	1,342	1,145	742	308	292
1937	10,830	1,240	742	908	1,876	1,314	1,329	1,114	723	311	298
1938	10,745	1,242	746	909	1,874	1,269	1,289	1,100	747	296	302
1939	10,629	1,229	743	899	1,828	1,268	1,255	1,096	751	290	307

[1] Figures from 1909 to 1936, inclusive, are from Eldon E. Shaw and John A. Hopkins, *Trends in Employment in Agriculture, 1909-36* (WPA N. R. P.. Report No. A-8, November 1938). Number of persons employed in 1937-39 from Division of Crop and Livestock Estimates, U. S. D. A. All figures refer to the average number of persons employed on farms on the first of each month.

These figures show a remarkable stability of employment in agriculture for the country as a whole. This apparent stability results from two opposite influences which were of approximately equal force during the period under consideration. On the one hand there was an increase in labor efficiency, and on the other, a growing demand for farm products.

Trends varied widely between different farming regions. In the corn area total farm employment declined over a fifth from 1909 to 1934, almost in a straight-line trend. Trends for family and for hired workers, however, differed as shown in figures 3 and 4. Family workers declined a fifth from 1909 to 1929 as against 9 percent for hired workers, while in the next 5 years, family workers increased slightly and hired workers dropped a third.

The two dairy areas followed divergent trends. The eastern dairy area witnessed a decline of about one-fourth from 1909 to 1930, with family workers and hired workers decreasing about equally. In the growing western dairy area, however, total farm employment was nearly the same at the end of the period as at the beginning, but with a small reduction in the number of family workers and an increase in hired workers.

In the middle eastern area the major change was a 10 percent drop during the World War. This was followed by a slow decline until 1930, then a reversal of trend and some increase in farm employment until 1935 were noted.

The three cotton areas followed individual trends. In the eastern area an almost continuous decline of about 1 percent a year took place from 1909 to 1929, as the boll weevil and deterioration of the land increased the economic pressure on persons engaged in farming. The net contraction was entirely in family workers; the number of hired workers was practically the same in 1929 as in 1909. In the delta cotton area a decline of 12 percent occurred in the first decade. This was followed by recovery during the 1920's as new family farms were opened up particularly in the bottomlands.

Total farm employment in the western cotton area followed a trend very similar to that in the delta area from 1909 to 1929, but there was this difference: Family workers in the western area declined relatively while hired workers increased about a quarter during the two decades. There was the further difference that the expansion of the 1920's in the western area was most pronounced in large mechanized farm units at the western edge of the region.

After 1929, employment contracted in all three of the cotton areas; but, as elsewhere, hired workers were affected much more than family workers. Numbers of the latter changed very little, while hired workers declined 14 percent to 30 percent in the different areas.

The small-grain area is the one in which mechanization has made the greatest advance. From 1909 to 1919 family workers and hired workers each declined about 5 percent. During the 1920's there was an increase in crop acreages, and hired workers increased from 182,000 to 210,000. From 1929 to 1936 the Agricultural Adjustment Administration programs reduced acreages planted, and destructive droughts resulted in partial or complete crop failures in many sections. Consequently there was less need for farm labor, and hired workers declined a third.

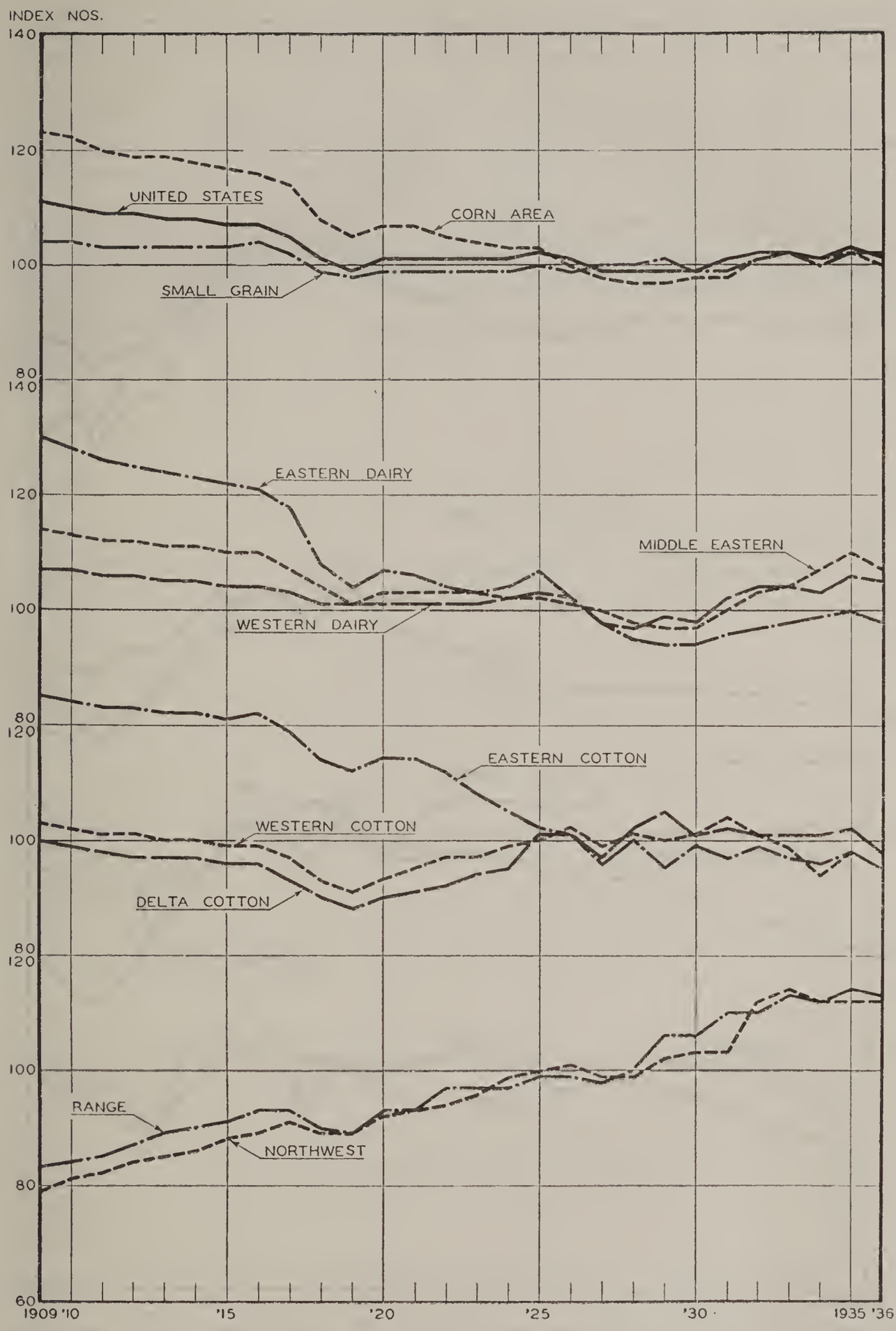

FIGURE 3.—Annual indices of employment in agriculture, family workers, 1909–36.

Source: Based on E. E. Shaw and J. A. Hopkins, *Trends in Employment in Agriculture, 1909–36*, WPA N. R. P. Report No. A–8, November 1938, tables 1, 3, 5, 7, 9, 11, 15, 17, 19, 21.

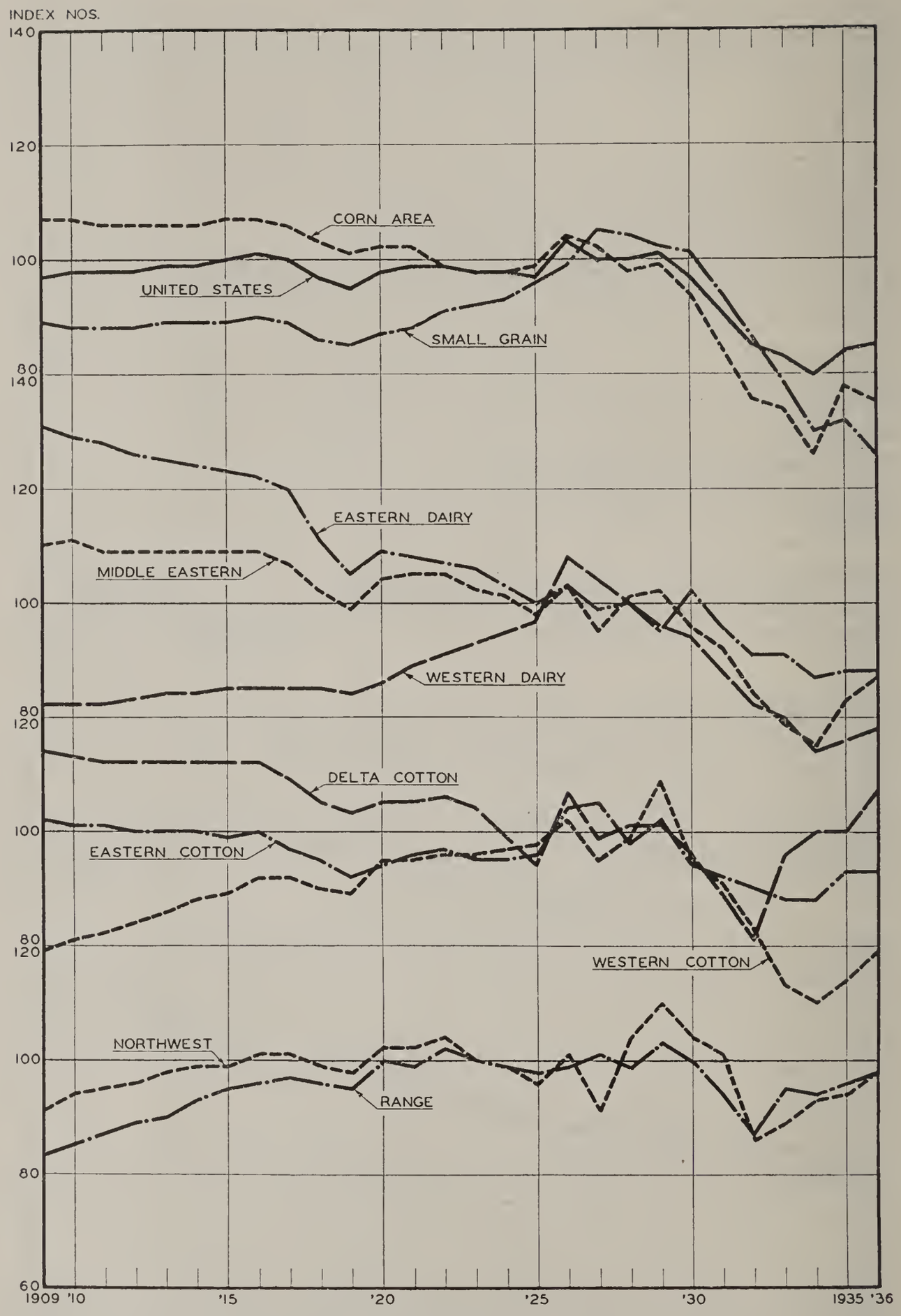

FIGURE 4.—Annual indices of employment in agriculture, hired workers, 1900–36.

Source: Based on E. E. Shaw and J. A. Hopkins, *Trends in Employment in Agriculture, 1909–36*. WPA N. R. P. Report No. A–8, November 1938, tables 1, 3, 5, 7, 9, 11, 15, 17, 19, 21.

Employment in the range area and in the northwestern area increased a quarter from 1909 to 1929, with the number of family and hired workers rising. The largest increase occurred in California, where total employment rose almost one-half during this 20-year period.

With an increase of 38 percent in the population of the United States from 1910 to 1935 something like a proportionate increase in agricultural employment might have been expected. Actually, only 1 person was employed in agriculture for each 11.5 persons in the total population in 1935, as compared to 1 person for each 7.6 persons in 1910. Had it been necessary to employ as large a proportion of workers in agriculture in 1935 as in 1910, the total number in the latter year would have been 16.7 millions, or 5.7 millions more than were actually employed.

CHAPTER III. SOME CHARACTERISTICS OF AGRICULTURE THAT AFFECT TRENDS IN EMPLOYMENT

THE FARMER A SELF-EMPLOYED WORKER

Employment in agriculture differs in many ways from industrial or commercial work. The typical farm worker is self-employed, whereas the average hired city worker performs a routine of daily duties, draws a predetermined amount of pay, and leads, as it were, two lives: One during working hours, when he is engaged in economic activity, usually under the direction of someone else, and the other after hours, when he is usually engaged in noneconomic activities with relatively little thought of the day's work.

On the farm there is no such division of activity. The farmer eats and sleeps within call of his work. His wife and children feel almost as much concern about the operation of the farm as he does himself. Consequently, the typical farm family tends to remain a social and economic unit. The life of the farm family cannot be disassociated from the activity of the farm itself. In most types of agriculture these facts give the family-sized farm such a great advantage over units employing more laborers that there seems no probability of the family unit being displaced by larger farms in the near future.

The degree to which self-employment prevails in agriculture is shown strikingly by figures from the census.[1] In the first week of January 1935 there was an average of 1.6 family workers per farm, including the farm operator, for the United States as a whole. On the other hand, fewer than 1 million of the 6.8 million farms reported any hired labor, and only 107,000 reported more than 2 hired workers per farm.

In the management of most types of farms the limitation on total size of enterprise is set by the increasing difficulty of maintaining labor efficiency as the farm grows larger. Except for certain operations on fruit and vegetable farms, it is not feasible to direct crews of workers on a scale at all comparable with work in factories, construction jobs, or even department stores. Such operations as preparing the seedbed, planting, cultivating, or harvesting corn, small grains, or hay, involve application of labor over such large areas that the farmer cannot direct effectively the activity of very many men. Further, the nature of the job changes from week to week as the season advances, and even from hour to hour with changes in weather. This creates the problem of shifting labor from one task to another, which becomes more difficult as the number of men increases. The result of these influences is that few farms employ even one hired man except in rush seasons.

[1] *United States Census of Agriculture, 1935* (U. S. Bureau of the Census, 1937), vol. III, ch. IV, table 9, p. 164.

LENGTH OF THE FARM WORKDAY

Farm work must be timed carefully. Planting, cultivating, and harvesting must be done within short, seasonal periods to obtain most profitable results. The farmer's earnings are proportionate to the time he works during the year and are closely related to the length of day he works in critical seasons. Self-employment and the seasonal nature of farm work both make for long workdays during these periods. In comparing the length of workdays on farms and in cities, however, it should be remembered that the city worker must spend considerable time going from his home to his work, while the farmer may lose but a few minutes in this way.

In nonfarm industries, the hours in a workday have declined steadily during most of the past century. In 1937 and 1938 manufacturing industries had workweeks averaging 38 to 39 hours.[2] This amounts to approximately 2,000 hours a year as against 2,800 to 3,000 hours in Northern agricultural areas in recent years (table 14), and about 2,000 in some Southern areas. Shorter workdays and more leisure have been important influences affecting the lives of urban workers. In recent years the shorter workday in cities has provided an added inducement in drawing farm workers to urban areas. Labor unions have been instrumental in shortening urban workdays, but labor organization is practically nonexistent in agriculture and has but little effect on hours where few farms have year-around hired workers, and where most of the work is done by persons whose income varies in proportion to their accomplishment. This is all the more true because even the hired hand works alongside his employer, and usually eats at the same table and sleeps in the same house.

The effect of mechanization in agriculture was partly to reduce the number of workers employed in operations like harvesting and seedbed preparation, and partly to lower the number of full workdays between rush seasons for the remaining workers, that is, usually for the farmer himself. On days when work is done, the number of hours seems to have been reduced relatively little and, on some critical operations, may even have been increased.

Present Length of Workday

In urban industries the reduction in working hours and the consequent increase in leisure during recent decades, and particularly since 1900, has been one of the most important economic gains. To what extent have farmers participated in this very real gain?

Table 12 and figure 5 show the length of workday on farms surveyed in the field study of 1936. These figures refer to a normally full field day. On days when field work is done, during crop-producing seasons, the average workday of farm operators in the Northern areas is about 12 hours. The activities of the workday vary considerably between the dairy areas and the corn and small-grain areas. In the former, more time is required to take care of the livestock, so that the field day is usually about 8 hours, while daily chores require 3.5 to 4.9 hours, depending on the season. In the corn area and the small-grain areas

[2] Data from U. S. Bureau of Labor Statistics.

the field day amounts to about 10 hours and chores to 2.5 hours. In the winter there is often little outside work, but livestock take much more time and chores amount to 6 or 7 hours in the dairy areas and 3.5 to 4.8 hours in the other sections.

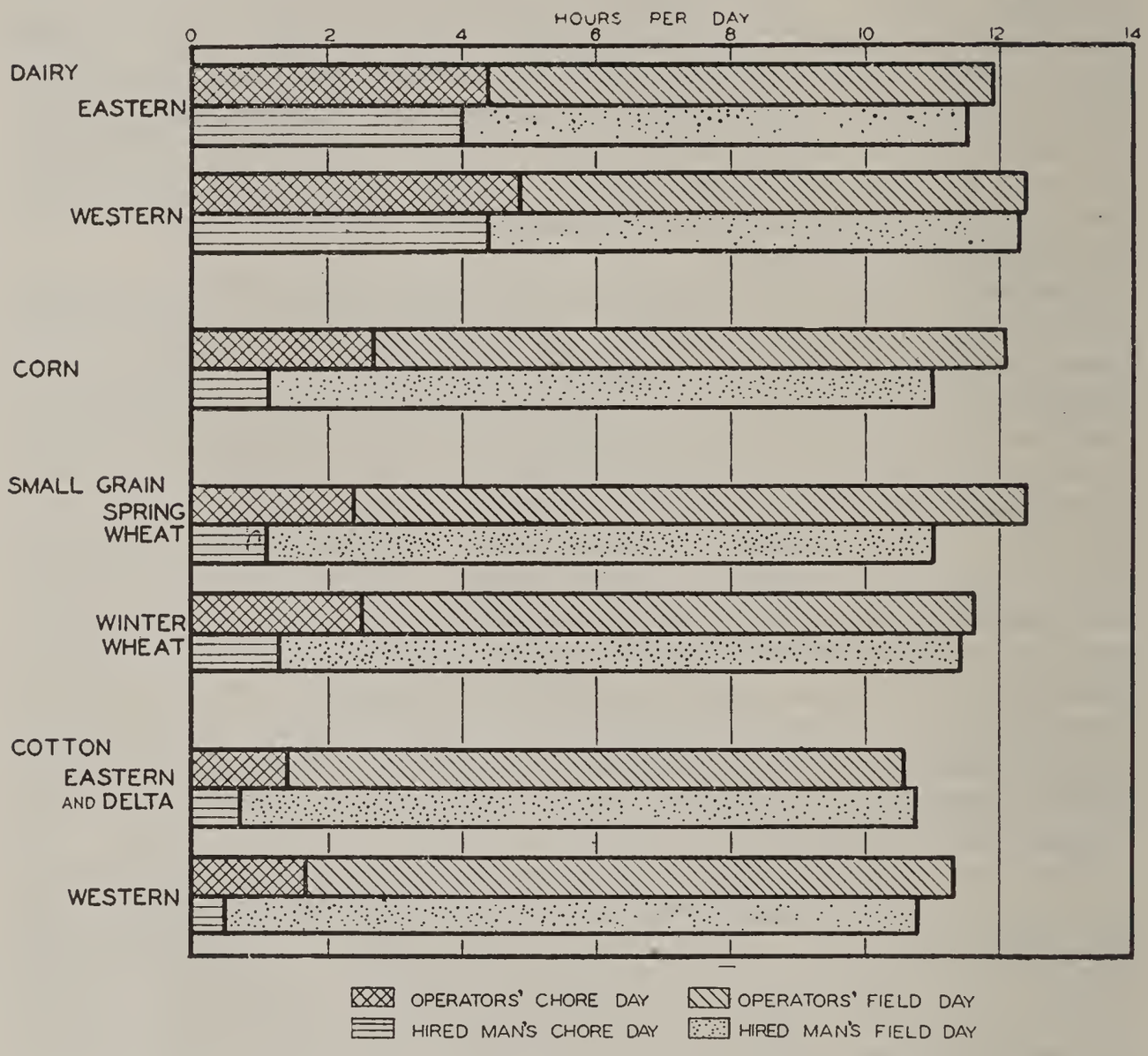

FIGURE 5.—Average farm workday by areas, spring quarter, 1936.

Source: Based on data in table 12.

In the southern areas, working hours are somewhat shorter. About 9.3 hours per day are spent in field work during the crop production seasons in the eastern and delta cotton areas and 9.6 to 10.5 hours in the western cotton area where larger crop acreages are grown. Since there is much less livestock to care for in the South, chores amount to only 1.4 to 1.8 hours a day throughout the year. In these areas, however, some crop-preparation work can be done during the winter and consequently some field work is reported.

The hired man's workday, as shown in table 12, is about 11 hours long in most areas and varies little from spring to fall. During the crop-production season, the hired man works longer in the field than the operator by amounts which run up to an hour in some areas, but spends from a half hour to two hours per day less than the operator at chores. The operator prefers to do, himself, the more exacting work and work that requires greater judgment, while the more routine work is left to the hired man.

TABLE 12.—*Length of farm workday in 1936* [1]

Area	Total workday [2]				Field day [3]				Chores			
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
FARM OPERATORS												
Eastern dairy	11.9	11.9	11.7	------	7.5	8.4	7.8	------	4.4	3.5	3.9	5.8
Western dairy	12.4	11.8	12.0	------	7.5	8.3	8.2	------	4.9	3.5	3.8	7.4
Corn	12.1	12.1	11.7	------	9.4	9.5	9.1	------	2.7	2.6	2.6	4.8
Spring wheat	12.4	12.5	11.8	------	10.0	10.2	9.5	------	2.4	2.3	2.3	4.4
Winter wheat	11.6	12.9	11.8	------	9.1	10.6	9.4	------	2.5	2.3	2.4	3.5
Eastern and delta cotton	10.6	10.7	10.7	7.7	9.2	9.3	9.3	6.2	1.4	1.4	1.4	1.5
Western cotton	11.3	12.2	11.6	9.3	9.6	10.5	9.9	7.5	1.7	1.7	1.7	1.8
HIRED WORKERS [4]												
Eastern dairy	11.5	11.0	11.2	------	7.5	8.4	8.0	------	4.0	2.6	3.2	6.1
Western dairy	12.3	11.6	11.6	------	7.9	8.7	8.5	------	4.4	2.9	3.1	7.9
Corn	11.0	10.9	10.5	------	9.9	9.9	9.5	------	1.1	1.0	1.0	4.8
Spring wheat	10.9	10.9	10.5	------	9.9	10.3	9.6	------	1.0	.6	.9	5.1
Winter wheat	11.4	11.3	11.0	------	10.1	11.0	10.2	------	1.3	.4	.8	4.0
Eastern and delta cotton	10.8	10.9	10.9	8.3	10.1	10.2	10.2	7.4	.7	.7	.7	.9
Western cotton	10.8	11.1	10.8	8.9	10.3	10.7	10.5	7.9	.5	.4	.3	1.0

[1] From N. R. P. field-study of 1936.
[2] Field day plus daily chores.
[3] Average number of hours for days when work was done.
[4] Averages of hours per day given for hired men represent the sum of hours reported for different farms divided by total number of farms reported.

Length of Field Day as Affected by Adoption of Tractor Power

The question often is asked whether the use of power machinery has affected the length of the workday on farms. In most areas, it is found that the farmers and their hired men put in 0.2 to 0.3 hour more per field day on farms with a tractor than on farms using only horses.[3] Farms with tractors only, which are found in the small-grain and the western cotton areas, average even longer hours than where there are both horses and tractors.

As tractors do not tire, it is possible to work them longer hours than horses, so there is a tendency to work longer days when conditions are right, with fewer days in the field. This effect is most pronounced in the small-grain area, in which the greatest pressure to seed or harvest crops within limited seasons is found.

Although the adoption of the machine undoubtedly lightens the work load in agriculture, it does not shorten work hours during the busy season, but rather reduces the number of persons employed or the number of days over which the busy season extends.

Changes in Length of Farm Workday Since 1915

A small reduction—probably a half hour and less than an hour—appears to have been made in most areas in the average length of the farm workday since the pre-war years.

[3] Eugene G. McKibben and others, *Changes in Farm Power and Equipment: Field Implements* (WPA N. R. P. Report No. A–11, 1939), table A–12.

Available data on this subject come from various farm surveys and farm-accounting studies and are difficult to compare but the consistency of the data is such that the general conclusion stated above seems well-supported.

Number of hours worked per day, when field work is done, differs from average number of hours worked for all weekdays. One of the most important reasons for this is found in weather conditions. A study in Chester County, Pa., in 1915, showed that, out of a total of 78 or 79 weekdays a quarter, only 45 were suitable for field work in the spring quarter, 65 in the summer and 52 in the fall. When averaged by quarters, the same length of field workday was reported in Chester County in the spring quarter of 1915 as in adjacent Lancaster County in 1936.[4] For the summer and fall quarters, however, the field workday was 0.4 hour shorter in 1936 than in 1915.

In regions having large increases in numbers of livestock, as in the western dairy area, the average number of hours worked a day may even have increased since the World War of 1914–18, if all days are averaged. Table 13 shows such an increase for sections of Minnesota, with greatest increases in the winter months when livestock require most care. The smaller increases in the summer season may also have been related to the greater number of livestock. Animals require some attention in summer, as well as in winter. Consequently, if a farmer keeps enough livestock to provide full employment in winter, he must either work longer hours in the summer or raise a smaller acreage of crops.

TABLE 13.—*Average number of hours worked per day on Minnesota farms*[1]

Area and county	Date of study	Hours worked per day	
		Workdays	Sundays
		Hours	*Hours*
Southeastern area:			
Rice	1902–07	8.9	3.6
Steele	1920–24	11.1	6.1
Southwestern area:			
Lyon	1902–07	8.7	3.1
Rock and Nobles	1929–31	9.4	3.1
Northwestern area:			
Norman	1902–07	8.1	2.8
Polk	1926–28	10.8	4.6

[1] Data from *An Economic Study of Agricultural Labor in Minnesota* (unpublished thesis by George A. Sallee) table 20, p. 63. Hours given are for workers working the entire year and averages are for all days. In this respect these figures differ from those obtained in the N. R. P. survey and from those shown for Illinois in table 14, both of which represent averages for full workdays.

In Hancock County, Ill., farm-accounting investigations disclosed an increase of about a half hour a day between 1914 and 1920.[5] This agrees with the observation of farm-management workers that farmers worked longer hours during the World War, when labor was scarce and high-priced. It also agrees with the increase in total

[4] According to a comparison of the National Research Project results with figures of G. A. Billings, *Seasonal Distribution of Farm Work in Chester County, Pa.* (U. S. Dept. Agr. Bul. No. 528, 1917), table 1, p. 8. The quarters given consist of 3 months each, the spring quarter beginning with the month of March.

[5] Based on unpublished data from the Department of Agricultural Economics, University of Illinois, by courtesy of H. C. M. Case.

number of hours per worker per year for the same period for New York, shown in table 14.

TABLE 14.—*Hours worked per year*

Area	Years	Type of farm	Number cases	Hours per worker per year	Hours per day	
					Weekdays	Sundays
Seneca County, N. Y.[1]	1919	Dairy	218	3,370	10.7	2.8
New York[2]	1914–20	do	229	3,055		
Do[2]	1921–25	do	156	3,138		
Do[2]	1926–30	do	326	2,989		
Do[2]	1931–35	do	396	2,981		
Wisconsin[3]	1922	do	23	3,405	9.9	6.2
Northern Minnesota[3]	1925	do	29	3,242	9.5	4.7
Southern Minnesota[3]	1923	General	23	3,224	9.6	4.5
Northern Ohio[3]	1923	do	17	3,283	9.0	3.9
Southern Ohio[3]	1923	do	20	3,027	9.7	4.5
Marshall County, Iowa[4]	1922–24	do	34	[5] 2,880		
Shelby County, Iowa[4]	1922–24	do	36	[5] 2,950		
Iowa County, Iowa[4]	1925–27	do	62	3,237		
Hancock County, Ill.[6]	1914–16	do	23	2,985		
do[6]	1920–22	do	26	3,162		
Champaign-Piatt Counties, Ill.[6]	1920–22	do	26	2,884		
Do[6]	1923–27	do	58	2,847		
Do[6]	1928–30	do	52	2,834		
Do[6]	1931–35	do	112	2,754		
Missouri[7]	1912–14	do	28	3,020	9.6	
South Dakota[3]	1925	Small grain	19	3,098	9.2	4.3
North Dakota[3]	1925	do	22	3,076	9.3	4.7
Kansas[3]	1925	do	21	3,273	9.7	4.4
Montana[3]	1920	Irrigated crops	16	2,831	8.3	4.2
Colorado[3]	1924	do	21	2,590	7.7	3.1
North Carolina[3]	1925	Tobacco and livestock	20	2,781	8.7	1.4
Texas[3]	1925	Cotton	19	2,024	7.7	1.8

[1] R. L. Gillett, *A Study of Farm Labor in Seneca County, N. Y.* (New York State, Dept. of Farms and Markets, Bul. 164), pp. 20, 28, and 33. Data obtained by survey.

[2] Unpublished data from Department of Agricultural Economics, Cornell University, Ithaca, N. Y. by courtesy of G. F. Warren.

[3] J. B. Hutson, *Working Days of Farmers a High Average* (U. S. Dept. Agr. Yearbook, 1926), pp. 785–786.

[4] Unpublished data from Iowa Agricultural Experiment Station, Ames, Iowa.

[5] Approximate.

[6] Unpublished data from Department of Agricultural Economics, University of Illinois, courtesy of H. C. M. Case.

[7] Missouri Agr. Expt. Sta Bul. 125, *The Cost of Production on Missouri Farms* by O. R. Johnson and W. E. Foard (1915).

After the World War there was a general decline in number of hours worked. This appears to have affected the number of days worked much more than the hours in a full workday. Thus, in the Champaign-Piatt area of Illinois, farm-accounting records indicate a reduction of only about one-fifth of an hour per full workday. But hours worked per month declined from 232 to 201, suggesting that farmers now have more time available for recreation, or for other activities.[6] The change has probably been greater, however, on these progressive, cost-accounting farms than on the average farm.

Changes in length of the working day are important for another reason. Working hours undoubtedly affect the rate of the farm-to-city migration to a degree exceeded only by relative wages. Declining working hours in the city may be expected to act as an even further stimulus to migration away from the farm.

[6] "Illinois Farm Economics," Dept. of Agricultural Economics, College of Agriculture, Univ. of Ill. (April and May 1939), pp. 242–243.

AGRICULTURE AND THE UTILIZATION OF LAND

Because farming must be adapted to many natural conditions, there is great variation in the percentage of cropland as between farming areas (table 15). In the corn area, for instance, 52 percent of the land in farms bore harvested crops in 1934. Seventy-five percent of this land could have been used for crop production if economic conditions and the requirement of sound cropping systems had not prevented. But in the range area, only 6 percent of the farm land was in harvested crops and only 20 percent could have been used for crops.[7] In the range area 73 percent of the land in farms is in open pasture which cannot be plowed, compared with only 9 percent in the corn area. The more humid eastern areas usually have a higher percentage of land in crops but they have also more woodland, of which only a part can be pastured. In the eastern cotton area woodland amounts to 44 percent, and harvested crops only 35 percent of the farm area.

TABLE 15.—*Utilization of land in farms, by percentages of all land in farms, 1934*[1]

Item	United States	Corn area	Eastern dairy area	Western dairy area	Middle eastern area	Eastern cotton area	Delta cotton area	Western cotton area	Small grain area	Range area	Northwestern area	California
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
All land in farms	100	100	100	100	100	100	100	100	100	100	100	100
Crop land harvested	28	52	37	47	27	35	36	22	22	6	22	22
Crop failure	6	3	1	4	(2)	1	1	5	17	5	2	1
Crop land idle or fallow	5	5	4	3	6	7	5	3	8	3	10	5
Plowable pasture	9	15	9	9	16	5	10	6	8	6	4	10
Woodland pasture	10	8	13	16	9	15	15	16	2	5	13	17
Other pasture	30	9	15	9	7	3	5	45	39	73	41	38
Woodland not pastured	8	3	15	5	29	29	21	1	1	(2)	3	2
All other land in farms	4	5	6	7	6	5	7	2	3	2	5	5
Land available for crops	49	75	51	63	50	47	52	36	56	20	38	38
ACRES PER FARM												
Total acres	155	120	94	125	76	83	65	242	415	663	216	202
Cropland harvested	43	63	35	59	21	29	23	53	91	42	47	44

[1] *U. S. Census of Agriculture, 1935*, vol. 1, adapted from table 3, pp. XX–XXVII.
[2] Less than one-half of 1 percent.

To get the greatest return, the farmer must select crop and livestock enterprises which can best utilize his type of land, make an efficient and economical operating unit, and use the available labor supply—which usually means the labor of the farmer and his family.

Varying combinations lead to an almost infinite variation in the internal farm organization. For each area, there are a few well-defined patterns or types of farms, although these are not always sharply defined and gradually merge into one another.

[7] The comparison can be somewhat misleading. The percentages for 1934 are not typical of other years because of the severe drought of that year, which hit the range harder than the corn area. Five percent of the farm land in the range area represented crop failure in 1934 as compared with only 6 percent in land harvested. In the corn area, only 3 percent represented crop failure, even in 1934. In other words, had there been no crop failure in 1934, the crops harvested would have amounted to 11 percent of the farm land in the range area and 55 percent in the corn area.

TYPES OF FARMS

The term "type of farm" is associated somewhat with geographical areas, as the cotton farms of the South, the wheat farms of the Great Plains regions, or the dairy farms of the Northeastern States. These geographical divisions are related in a general way to certain forms of agriculture, nevertheless, as table 16 shows, there are still great differences between types as well as between individual farms within each region.

TABLE 16.—*Percentage distribution of farms by types and farming areas, 1930* [1]

Type of farm	Farming area											
	United States	Corn area	Eastern dairy area	Western dairy area	Middle eastern area	Eastern cotton area	Delta cotton area	Western cotton area	Small grain area	Range area	Northwestern area	California
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
All types [2]	100	100	100	100	100	100	100	100	100	100	100	100
General	19	32	25	27	20	6	7	11	20	16	17	4
Cash grain	8	16	1	4	1	(3)	1	6	42	12	15	4
Cotton	29	(3)	0	0	16	79	82	68	(3)	4	0	2
Crop-specialty	8	2	6	6	26	6	1	1	3	20	12	7
Fruit	2	1	4	2	1	1	1	1	(3)	3	13	43
Truck	1	1	3	1	1	1	1	1	(3)	3	2	6
Dairy	11	11	42	47	3	1	1	2	3	7	18	13
Animal-specialty	9	27	2	7	4	1	1	2	23	8	4	2
Stock ranch	1	(3)	(3)	(3)	(3)	(3)	(3)	3	4	17	4	4
Poultry	3	4	8	2	2	(3)	(3)	1	2	4	9	13
Self-sufficing	9	6	9	4	26	5	5	4	3	6	6	2
Number of farms [2] of types included (thousands)	5,616	745	345	489	912	616	666	640	475	130	139	119

[1] *Fifteenth Census of the United States: 1930*, Agriculture, vol. IV, ch. XIV, table 6, pp. 892–903.
[2] Omission: Abnormal and unclassified farms.
[3] Less than one-half of 1 percent.

For the United States as a whole, cotton farms were the most numerous and comprised 29 percent of the total in 1930. Eleven percent were dairy farms and 9 percent were animal-specialty farms of other types, such as hog farms or cattle-feeding farms. Cash-grain farms and those with other crop specialties made up 8 percent each. The general or diversified farms amounted to 19 percent of the total, but this is a very heterogeneous group. Dairying may be the most prominent enterprise on the general farm of New York, while corn and hogs are outstanding enterprises on Iowa general farms, and wheat predominates on those in North Dakota.

Besides these specialized or commercial types there are also "self-sufficing" farms on which families consume the greater part of the goods they produce. These, as defined in the Census of 1930, comprise 9 percent of the total number and occur most commonly in the mountainous sections of the middle eastern area, where they make up 26 percent of the total.

Each of the other areas has, also, its three or four principal types. In the corn area animal-specialty farms, chiefly hog or cattle-feeding

farms, make up 27 percent, and there are also many cash-grain farms, dairy farms, and general farms. In the two dairy areas, dairy farms make up over 40 percent of the total, and general farms 25 percent or more. In the three cotton areas, 68 percent to 82 percent are cotton farms but other types are important even here.

FARM TENURE

One of the most important characteristics of an agricultural system is the tenure under which the land is held and operated. In the United States in 1935, 47 percent of the farms were operated by full owners, 10 percent by operators who owned part of their land and rented some in addition, and 42 percent by tenants, roughly a fourth of whom were Southern sharecroppers (table 17). Under the sharecropping system the landlord provides all work animals and equipment.[8] Cropper holdings might, with considerable reason, be counted as subordinate units within large farms or plantations which are usually operated by owners.

Where the system of operation is simple or routine in character, as in the cotton area, or where land prices are high, as in the corn area, the highest percentage of tenancy is likely to be found. Where land prices are low, or where a careful husbanding of natural resources is necessary for continued returns, ownership has greater advantage. In the small-grain area, with its large investment per farm, the tenancy rate is more than 40 percent. In the eastern and western dairy areas, with lower priced and smaller farms and with more expensive buildings and equipment, only 14 percent and 24 percent, respectively, of the farms are operated by tenants.

TABLE 17.—*Percentage of farms by tenure, 1935* [1]

Area	Full owners	Part owners	Croppers	Other tenants	Managers
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
United States	47	10	10	32	1
Corn	48	13	(2)	38	1
Eastern dairy	78	7	(2)	14	1
Western dairy	62	13	(2)	24	1
Middle eastern	52	9	14	25	(3)
Eastern cotton	30	5	28	36	1
Delta cotton	31	4	34	31	(3)
Western cotton	32	8	13	46	1
Small grain	33	23	(2)	43	1
Range	57	16	(2)	26	1
Northwestern	65	11	(2)	23	1
California	66	8	(2)	22	4

[1] *U. S. Census of Agriculture, 1935*, vol. I, table III, Supplemented for the Southern States.
[2] Croppers not enumerated for these areas.
[3] Less than one-half of 1 percent.

EFFECTS OF TENANCY ON LABOR REQUIREMENTS

The form of land tenure is important in the adoption of some types of labor-saving methods and equipment, but the precise relationship varies from one area to another. In cotton production the large amount of seasonal hand labor makes for small operating units. The

[8] *U. S. Census of Agriculture, 1935* (U. S. Bureau of the Census, 1937), vol. III, p. 103.

nature of the available labor supply, and of the crop itself, and the desire of the plantation owner to divide the risks of price and yield with the persons making the crop have led to the present share-cropping system. Most of the present cropper or tenant farms in the South are too small to take advantage of available power equipment or even of larger sized horse equipment unless these are provided by the plantation operator.

In the South, investment in buildings and improvements is relatively small, so that it would be possible in some areas to consolidate the cropper units into larger ones with relatively small capital losses, though with incidental displacement of a considerable number of workers. In fact, this movement is obviously under way in areas with large plantations and conditions favorable to mechanization.

In the corn area the large proportions of rented land theoretically facilitate the consolidation of farm units when machinery of larger capacity becomes available. But there are offsetting influences and relatively little consolidation has occurred as yet. In the small-grain area the average size of farm increased from 1910 to 1920, but most of this was attributable to consolidation of homesteads which had been found too small to support a family on semiarid land. There was relatively little change in average size after 1920.[9]

In the dairy areas most of the farms are owned by their operators, and many are too small to utilize large-capacity equipment advantageously. With a high percentage of owner-operated farms, however, a farmer who wishes to enlarge his operations has difficulty in finding additional land contiguous to his farm which he can rent or buy. Thus, the operation of the major part of the land on an ownership basis may make adjustment to certain types of labor-saving techniques slower and more difficult.

DYNAMIC FORCES AND INERTIA IN AGRICULTURE

Urban people and even many farm dwellers are likely to regard agriculture as an industry that changes only slowly and then in minor details. This may be so in some respects. Farming, however, is affected constantly by many powerful forces, both of natural and of man-made origin. Technological developments are among the more important of these, and often cause long-continued economic pressures which ultimately bring pronounced shifts between farming areas as well as changes in methods used on the individual farm.

Agriculture a Dynamic Industry

Development of machines like the tractor, the combined harvester-thresher, or the mechanical corn picker brings an opportunity for profit. The profit motive can be depended upon to force wider and wider adoption until the machine is in general use in areas in which natural and economic conditions favor it. But the process of adoption is seldom rapid, even though favoring circumstances, like high farm prices or scarcity of labor, may cause large purchases in some

[9] *U. S. Census of Agriculture, 1935*, vol. III, ch. II, table 5, p. 51.

years. Tractors with internal combustion engines, combines, and mechanical corn pickers were all available for 20 years or more before widespread adoption occurred. In each case adoption required a long period, partly because of the time needed to perfect the machine itself and partly because many farmers were not convinced of its profitableness until some time after each machine became available.

Improvement of the genetic basis of agriculture—the development of new crops or of improved varieties of old ones, etc.—is a second source of gradual but persistent change. A third cause is found in shifts in consumer demand and development of synthetic products. These influences make their effects felt through changes in values of farm products and in net farm returns. As there are a multitude of causes and many wide fluctuations in such values, however, it may be several years before individual farmers finally realize the advantage of making a change.

Other influences are of a sudden and catastrophic nature. Among the strongest of these may be mentioned the periodic occurrence of wars which upset the whole economic structure of a nation and force upon farmers, as well as other groups, complete new sets of values and new business objectives. Nor is the farmer immune to influences from such purely economic upheavals as those which occur when a new area of agricultural land is opened up, when a major industry becomes overexpanded, or a banking system collapses. Indeed, he is usually affected even more than most other business men because prices of farm products react sharply both in the boom period and in the subsequent collapse.

Other industries are affected by economic upheavals about as much as is agriculture. But farmers have added, to an especial degree, the hazards of natural mischances, and may see the fruits of their efforts wiped out by drought, hailstorms, floods, or grasshoppers, plant or animal diseases, or insect pests. Some of these afflictions leave little permanent change in the farm organization or methods, but others, like the boll weevil, may lead to a permanent shift in the agriculture of the region affected. The campaign to eradicate tuberculosis among dairy cattle has stimulated adoption of sanitary practices and of public control over the production of market milk. The droughts of the 1930's in the small-grain and corn areas may bring about some permanent changes in cropping practices and in methods of culture.

Finally, farmers, like other business men, have always been affected by public policy, which, with the great increase in governmental intervention, has come to be one of the strongest influences affecting agriculture. This is true not only of policies aimed directly at the control or benefit of agriculture but also of tariffs, labor regulations, control of public utilities, and so on, which affect industries affecting farming costs on the one hand, or buying farm products on the other. During the 1930's, farm groups became conscious of their specific interests and in order to advance them have brought political pressure to bear on governmental units in a more effective manner than during the sporadic agrarian movements of a few decades ago. This political factor may prove to be one of the most powerful, as well as the most dynamic of those affecting the direction of agricultural activity and the returns obtained from it.

Elements of Inertia

Agriculture, then, is subject to many dynamic forces and is continuously in a process of readjustment, but nevertheless it contains a large degree of inertia. This is partly because of the long production period of some of the farm enterprises, but to a greater extent because of certain conditions under which the farmer himself lives and works. It might be summed up by saying that most of the dynamic influences are external while the inertia centers mostly in the farmer himself.

Until 1900–1910 the farmer and his family lived under conditions of much greater physical isolation than other economic groups. Living at some distance from their neighbors, farm people were naturally individualistic, strongly traditional in outlook, and slow to change. Particularly in former days, another important influence was felt by the farmer which was related partly to the isolation just mentioned, and which a city-bred person may find difficult to grasp.

The farm itself was more than a place to work, and there was a sort of spiritual harmony between the farmer and his land. The needs of the farm dominated the family's daily activity but, particularly in the older and less commercialized farming sections, a sense of unity existed between the farm dwellers and their fields and barns.

Traditionalism and reluctance to change was natural among people living under these conditions and dominated by the continuously shifting and yet unchanging demands of the land. Traditionalism was strengthened by the fact that farming involves an elaborate mass of manual skills that a young farmer can learn only by working with his father or by observing closely the work of a neighbor. Tradition and inertia are consequently a part of the farmer's heritage, and a change in method often requires a genuine mental effort.

Agricultural colleges and extension services have done much to remove the drag of inertia in agriculture. They have implanted many improved methods among the more alert and successful farmers, and these methods have later been copied by increasing numbers of neighbors. Another influence, probably even more effective in overcoming the physical isolation and the intellectual differentiation of farm people, is the improvement in communication since 1900.

The first breach in the farmers' differentiation from city dwellers was made by the telephone which put farm families in touch with each other and with their trading centers. Automobiles and improved roads followed, particularly after 1910, and greatly increased the radius within which the farmer and his family could travel and observe. The farm dweller began to lose his consciousness of belonging to a different group and his feeling of social ineptness. The differentiation into two great groups, rustic and urban, rapidly became less pronounced.

After 1920 came the radio, which enabled the farmer to keep in almost instant touch with the markets for his staple products and to receive national and world news as quickly as most city residents. As a further subtle but powerful influence, the radio brings into his own living room much of the same form of entertainment or amusement to which the urbanite is simultaneously exposed. Even though many farms still lack conveniences, the farmers of the country are becoming

urbanized to a degree which would have seemed amazing a few years ago.

More important, a subtle change in the way in which the farmer regards his farm has come about. More and more it becomes simply a place to earn a living and is regarded in a colder, more commercial light. The bonds that used to tie the farmer to the soil are rapidly dissolving and the incentive required to move him and his family is rapidly becoming less. A considerable degree of inertia, however, still remains and provides a limit to the rate at which farm technology can improve.

This inertia consequently limits the rate at which population can be released for employment (or to face unemployment) in the cities. There are still many farmers and many farm youths who have a strong emotional feeling for the land and who would not be happy elsewhere. But their number is clearly growing smaller. In the meantime the number who are ready and eager to seek their fortune in the city grows larger and the transition from farm to city life becomes shorter and easier to make.

CHAPTER IV. CHANGES IN CAPITAL FORMATION ASSOCIATED WITH TECHNOLOGICAL IMPROVEMENTS IN AGRICULTURE

Changes in the processes of production, whether on or off the farm, imply corresponding changes in the instruments used. In agriculture this general principle has been doubly true because the change in process has often originated in improvements in the power units or in farm implements.

When technological changes call for new equipment, costs may retard or, under some conditions, prevent the advance in methods. To what extent has this been true in agriculture? Have the changes in agricultural technology actually required more capital in the aggregate than did older methods? If so, which types of capital have been affected? Have some groups of farmers been placed at a disadvantage by the increased investments required? Although it may not be possible to answer these questions fully, we can at least indicate the approximate change in capital requirements since 1915 and the form which it has taken.

FARM VALUATION AND FARM CAPITAL IN 1930

The term "capital" must not be confused with the total investment in agriculture, nor with the valuation of farms and their improvements and equipment. Land is by far the largest item of farm investment enumerated by the census and accounted for nearly 70 percent of the total (table 18).[1] This, obviously, does not represent capital goods at all, in the economic sense, but merely the valuation of natural resources utilized. This valuation does include fences, drains, and other man-made improvements which were not separated from the land in the census figures. These improvements affect the productivity of the land, but account for a relatively small fraction of the valuation shown. The rest of the 35 billion dollars is based on anticipated income from use of the land rather than any original investment made in it.

Valuation of land has varied widely from decade to decade, depending on the prices of farm produce and the prospective income from crop production. For 1910 the census reports a figure of 28 billion dollars; but by 1920, at the end of the wartime boom, the valuation was 55 billion. In 1930, valuation of land was given as 35 billion, and in 1935 a 6 percent greater area of farm land, plus farm buildings, was valued at only 33 billion dollars.

[1] The enumerated figures do not include crops and supplies on hand, which would probably have added 3 or 4 percent to the total.

TABLE 18.—*Value of principal types of farm property in 1930* [1]

Item	Value	Percentage of total investment	Percentage of capital items
	Million dollars	*Percent*	*Percent*
Total of specified items	50,162	100	
Land, fences, drains, etc.	34,930	70	
Total capital goods	15,232	30	100
Buildings other than dwellings	5,866	12	39
Motive power	2,771	5	18
Tractors	368		
Trucks	225		
Automobiles	827		
Workstock	1,351		
Equipment other than automotive	1,882	4	12
Livestock other than work stock	4,713	9	31

[1] Source: *Fifteenth Census of the United States, 1930*, Agriculture, vol. IV, except where otherwise indicated. Total value, land, and buildings from p. 21. Value of dwellings of farm operators has been subtracted from buildings and from total. This amounted to $7,083,536,150. Valuations of horses, mules, asses, and burros from pp. 551–552 were added to obtain total work stock. No valuations were given for tractors, trucks, or automobiles on farms. The numbers reported for 1930, p. 530, were multiplied by $400, $250, and $200, respectively. Valuation of equipment other than automotive consists of the total value of equipment of $3,301,654,481 given on p. 21, less the estimated values of tractors, trucks, and automobiles on farms. Valuations of livestock other than work stock were obtained by subtracting values of horses, mules, asses, and burros from total value of livestock of $6,064,051,430, as given on p. 21.

The second largest element of farm valuation consists of buildings, which amounted to 13 billion dollars in 1930, including 7 billions for dwellings. The remaining 6 billions represent buildings used in the farm business and amount to 12 percent of the total value of specified types of property. This valuation, like that of the land, is an anomalous one, though for a different reason. It does not represent the actual investment, depreciated, nor does it indicate the amount that would be required to replace the buildings. The census valuations represent what the farm property could be sold for, in the estimation of the farmer, and "under normal conditions." The resale value is probably less than the depreciated original investment since the more expensive farm buildings seldom add as much as their cost to the sale value of the farm.

A farm requires a certain minimum amount of shelter for livestock, plus storage space for crops and for the more valuable farm implements. Beyond this, further improvements in buildings must be regarded as primarily for the farmer's own gratification rather than to increase his monetary income.

The largest recent investment in buildings has probably come from the westward expansion of dairying. This enterprise requires relatively expensive shelter for the cows plus silos on many farms, and facilities for cooling and storing the milk.

If valuation of the land (including fences and drains) is omitted, total capital goods used in the farm business in 1930 amounted to 15.2 billion dollars. Of this, 39 percent was in the form of buildings, 18 percent in motive power, 12 percent in implements, and 31 percent in livestock other than workstock. It should be noted that about one-third of the investment in motive power was in the form of automobiles, which are used both for business and for personal purposes.[2]

[2] See WPA N. R. P. R. report No. A–9, *Changes in Farm Power and Equipment, Tractors, Trucks, and Automobiles*, pp. 37–60, for further discussion of this subject. Probably about half the investment in farm automobiles might reasonably be allocated to the farm business. No such allocation has been made here, however, since if this were done it would be necessary for consistency, to attempt to divide the investment in horses in earlier years between farm and personal uses. There appears to be no satisfactory basis for such a separation. Thus in 1909, except for an unknown number of "driving horses," the same farm horses were used both for farm work and for personal driving or hauling.

Investment in Drainage and Irrigation Projects

In certain parts of the country important investments have been made in drainage or irrigation works. Much land in the Middle West and along the Mississippi and its tributaries needed to be drained before it could be used for crop production. Other land was drained to increase its productivity. About one-third of the land in drainage enterprises in 1930 was located in the corn area, and a third in the western dairy area. Projects of this type, which were mostly of a semipublic or cooperative type, represented investments of 681 million dollars, according to the census (table 19). About one-half of the 84 million acres of land in question had been drained before 1910, and most of the remainder before 1919. These figures, however, do not include work done by the farmers themselves in laying tile or in opening ditches for the benefit of their individual farms. Valuation of these farm-drainage systems is included in the valuation of land in table 18.

Table 19.—*Land drained and capital invested in drainage enterprises, by date of organization, 1930* [1]

Date of organization	Land	Capital invested to Jan. 1, 1930
	1,000 acres	*1,000 dollars*
All enterprises	84,408	680,733
Before 1910	41,440	219,208
1910–14	16,448	125,953
1915–19	15,803	190,583
1920–24	7,428	102,977
1925–29	3,289	42,012

[1] *Fifteenth Census of the United States, 1930,* Drainage of Agricultural Lands, part I, table 9, p. 22.

In the arid or semiarid areas large sums have been spent in developing irrigation works, chiefly in the range, northwestern, and California areas. According to the census, such investment amounted to slightly over 1 billion dollars in 1930 (table 20). The number of farms reporting irrigated land increased more than 80 percent between 1910 and 1935, but acreage under irrigation expanded much less than this. Since the supply of water was the limiting factor in irrigated sections, this added investment has been closely related to the increased output of farm produce.

Capital Per Worker

Agriculture involves relatively large investments of capital per worker and a relatively slow turn-over on the investment. With an average of 11.2 million workers in agriculture in 1930, the average total investment per worker in the resources listed in table 18 amounted to $4,489. Roughly two-thirds of this, or $3,126, was in land, while capital goods amounted to an average of $1,363.

When the $1,363 of capital goods is further broken down, it is found that $525 was in the form of buildings (omitting the operator's dwellings). Livestock, other than workstock, were worth $422 per worker, while $416 represented implements and sources of motive power. The productivity of labor in agriculture since 1910 has been related most

strongly to the process of mechanization, and it is the changes in this investment of $416, rather than the $1,363 of total capital goods or the $4,489 of total investment that must be watched most carefully.

TABLE 20.—*Number of farms with irrigated land, and acreage irrigated, by census periods, 1910–35* [1]

Year	Number of farms reporting irrigated land	Irrigated land	Irrigated land from which crops were harvested	Investment [2]
	Number	*1,000 acres*	*1,000 acres*	*Million dollars*
1910 [3]	162,723	14,433		
1920 [3]	222,789	19,192		698
1930 [3]	265,147	19,548	14,633	1,033
1935	296,189		13,034	

[1] *United States Census of Agriculture, 1935*, vol. III, General Report, ch. I, table 1, p. 18.
[2] *Fifteenth Census of the United States, 1930*, Irrigation of Agricultural Lands, table 25, p. 29.
[3] 19 States only.

Investment as Related to Size and Type of Farm

Generalizations regarding the amount of investment or the amount of capital used in agriculture need to be qualified with regard to the size and type of farm. The larger farms, naturally, have the greater total investments per farm in land, buildings, or machinery. When expressed per acre, however, valuations are found to vary inversely with size of farm. The smallest farms are usually on better land and are more highly improved than the large ones. The average valuations per acre on farms of under 20 acres were nearly 4 times as high for land and implements and nearly 6 times as high for farm buildings as on farms of 175 to 499 acres. The average large farm contains a greater proportion of pasture or wasteland. Farms of 500 acres or larger included a large number of stock ranches and small-grain farms and the valuations per acre were much lower than in the groups mentioned.

From 1910 to 1930 there were increases in valuations per farm amounting to 9 percent for land alone, 82 percent for buildings other than dwellings, and 133 percent for implements (including tractors, automobiles, and trucks).[3] The increase per acre in land and buildings was less on the larger farms than on the smaller ones, but with implements and machinery a greater increase occurred on farms of intermediate sizes than on either the small or the large farms. A large part of the increase came from the purchase of tractors, trucks, and

[3] It should be kept in mind throughout this discussion that the capital used in farm production consists of physical goods and not of amounts of money. It is necessary to use valuations in terms of money because information is lacking on the quantities of such goods. Further, even if the data on physical quantities were available, it would not be possible to add together numbers of tractors, cattle, hogs, rods of fencing, and so on to get an expression of the total capital. Use of the valuations permit such a summation at the existing price levels in any particular year—subject, however, to certain qualifications. This enables us to obtain some idea of the relative importance of the different classes of capital at a given time. It also permits us to make a rough comparison of the relative changes in quantities of capital of the several sorts, after corrections are made for the changes in the price level. Such comparisons will be made, as far as available data permit, a little later on in this chapter. Not even the valuations corrected for changes in price level, however, are entirely satisfactory for a comparison of capital between different years. Many of the machines, for instance, have been improved in design and effectiveness without increase in their purchase price.

automobiles, and it was on farms of 100 to 999 acres that the shift to power equipment was greatest.

Wide differences among types of farms are found. At the one extreme are stock ranches, which averaged 2,912 acres in 1930, and had land worth $8.69 and buildings and equipment worth $0.82 per acre (table 21). Cash-grain farms, which come next as extensive enterprises, had land worth $41.76 and buildings and implements valued at $8.10 an acre. At the other extreme in capital and labor intensity we find the fruit farms, with land and trees (which are not possible to separate in these figures) valued at $207.92 an acre, while farm buildings and implements amounted to $28.81 an acre.

Intensity, however, may be represented either in the application of capital or of labor per acre. Cotton farms are much more intensive than cash-grain farms in labor, but have less capital, both per farm and per acre. With 72 acres to a farm, their buildings and equipment were valued at $4.96 an acre, and with a total investment of only $2,691 for land, buildings, and equipment. In between the extremes lies the "general" or diversified farm which for the country as a whole averages 138 acres of land valued at $4,851, and with farm buildings and equipment valued at $1,599 or $11.57 an acre.

TABLE 21.—*Average value per farm and per acre of specified classes of farm property, by types of farm, 1930* [1]

Type	Land alone		Buildings except dwellings		Implements and machinery [2]	
	Per farm	Per acre	Per farm	Per acre	Per farm	Per acre
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
All types	5,555	35.40	933	5.94	525	3.35
Stock ranch	25,317	8.69	1,363	.47	1,025	.35
Fruit	14,744	207.92	1,220	17.13	831	11.68
Cash-grain	14,683	41.76	1,471	4.19	1,373	3.91
Animal-specialty	12,225	53.22	2,112	9.20	1,071	4.66
Dairy	5,933	42.82	2,020	14.59	951	6.87
Truck	7,304	121.04	904	15.08	666	11.11
General	4,851	35.14	1,057	7.65	542	3.92
Crop-specialty	4,480	40.95	735	6.71	434	3.96
Poultry	3,132	50.36	1,161	18.56	426	6.81
Cotton	2,332	32.27	189	2.61	170	2.35
Self-sufficing	1,500	21.57	301	4.33	125	1.80

[1] Source: *Fifteenth Census of the United States, 1930*, Agriculture, vol. III, pt. 1, State tables I, II, pp. 12, 18.
[2] Including tractors, trucks, and automobiles.

CHANGES IN PRINCIPAL TYPES OF FARM CAPITAL SINCE 1910

From 1910 to 1920 there was a sharp rise in the valuation both of farm land and of the capital goods used in conjunction with it. The acreage of land in farms in 1920 was 9 percent greater, and in 1930 was 12 percent greater than in 1910. The valuation, however, rose 93 percent between 1910 and 1920 and then fell back in 1930 to a level 23 percent above 1910. Buildings, machinery, and livestock also fluctuated much more in valuation than in amount, but showed a more pronounced upward trend. Thus, an increase of 83 percent in the combined valuation of these resources from 1910 to 1920 occurred, and in 1930 they were still 66 percent above 1910. The greatest increase occurred in implements and machinery (including tractors and

automobiles) which in 1930 were valued at 261 percent as much as in 1910. On the other hand, workstock in 1930 were only 52 percent as high. Between 1930 and 1935 the value of farm capital declined about a fourth. Part of this came from deterioration of buildings and equipment, but about half was due to lower valuations of livestock.

Whereas the number of farms increased somewhat, the valuation of capital goods per farm rose less than did the total. Thus, the valuation of all capital goods was $1,441 per farm in 1910, and $2,420 in 1930, an increase of 68 percent. Further, the number of persons working on farms has declined since 1910 so that the investment in capital goods per worker rose 81 percent from $755 to $1,363 (table 22).

A worker's effectiveness, as already pointed out, does not depend merely on the value of the capital goods he uses. The form of the implements and other goods may be even more important than the total amount of capital. Much of the valuation is partly subjective and at any census date is influenced by the agricultural outlook as well as by the amount of the capital goods. This is well illustrated by the wide changes in valuation of land and of buildings, between 1910 and 1920 and between 1930 and 1935, although their physical composition changed but little. Changes in physical amounts of the principal types of capital, as well as their values are examined in the following pages insofar as available information permits.

TABLE 22.—*Farm capital investment per worker, at current prices, by specified class of investment and by farming areas for specified years, 1910–35* [1]

Class of investment	United States	Corn area	Eastern dairy area	Western dairy area	Middle eastern area	Eastern cotton area	Delta cotton area	Western cotton area	Small grain area	Range area	Northwestern area	California
Total capital goods:	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
1910	755	1,367	1,131	1,115	377	187	228	555	1,632	1,312	1,095	1,038
1920	1,476	2,713	2,144	2,323	717	418	465	1,088	3,176	2,402	2,074	1,819
1930	1,363	2,551	2,286	2,447	670	288	319	915	2,823	2,081	1,824	1,569
1935	1,015	------	------	------	------	------	------	------	------	------	------	------
Buildings: [2]												
1910	236	490	541	452	113	44	41	89	385	164	230	264
1920	458	991	886	905	227	103	91	199	826	319	467	469
1930	525	1,148	1,118	1,105	280	97	87	216	869	369	570	560
1935	483	------	------	------	------	------	------	------	------	------	------	------
Machinery:												
1910	104	168	189	164	47	29	39	69	227	115	174	170
1920	316	575	474	513	132	91	94	200	771	351	525	523
1930	296	484	516	500	116	60	77	221	759	366	477	410
1935	227	------	------	------	------	------	------	------	------	------	------	------
Workstock:												
1910	216	364	184	244	130	79	96	208	552	287	339	264
1920	226	312	211	226	162	129	153	252	497	286	288	165
1930	121	202	126	176	95	66	69	112	211	128	118	57
1935	125	206	129	169	93	81	67	130	213	134	138	63
Other livestock:												
1910	199	345	217	255	87	35	52	189	468	746	352	340
1920	476	835	573	679	196	95	127	437	1,082	1,446	794	662
1930	421	717	526	666	179	65	86	366	984	1,218	659	542
1935	180	323	286	261	81	40	45	155	343	466	308	297

[1] Data from appendix table B-1 divided by average total agricultural employment, from E. E. Shaw and J. A. Hopkins, *Trends in Employment in Agriculture* (WPA N. R. P. Report No. A-8).

[2] Buildings other than operators' dwellings.

The Shift in Sources of Farm Power

The shift from horses to mechanical sources of power has caused one of the most important changes in the make-up of agricultural capital. Between 1920 and 1930 the value of horses and mules on farms declined by almost a half, but this was more than offset by the increased investment in tractors, trucks, and automobiles. The approximate total investment in prime movers on farms rose from 2.7 billion dollars in 1910 to 3.6 billion in 1920, and then fell to 2.8 billion in 1930 (table 23). Meanwhile, horses, representing 98 percent of the value of farm motive power in 1910, had fallen to 50 percent in 1930.

The process by which this shift in type of investment occurred is an interesting one. As farmers found opportunities for the profitable adoption of mechanical power, demand for horses decreased, and with it the prices of horses and colts. Thus, the average price of a horse was slightly lower in the years from 1913 to 1918 than in the period 1910–13, although the price index for all farm products doubled in the same period.[4] This made it unprofitable to produce colts, and only 1,864,000 were raised in 1918 as compared with 2,349,000 in 1913 (fig. 6). Horses continued low in price, as compared to other farm products, until after 1930, by which time the number of colts raised each year had fallen to around 500,000.

Table 23.—*Approximate value of prime movers on farms in the United States for specified years, 1910–35*

Year	Value at current prices			Value at 1924–29 prices		
	Total	Horses and mules [1]	Tractors, trucks, and autos [2]	Total	Horses and mules per farm [3]	Tractors, trucks, and autos per worker [4]
	Mil. dol.	*Mil. dol.*	*Mil. dol.*	*Mil. dol.*	*Dollars*	*Dollars*
1910	2,699	2,649	50	1,715	279	141
1920	3,597	2,781	816	2,349	377	207
1930	2,833	1,413	1,420	2,762	443	247
1935	2,801	1,393	1,408	2,711	416	243

[1] *Agricultural Statistics, 1937* (U. S. Dept. Agr.), p. 290.

[2] Number of tractors, trucks, and autos for 1920 and 1930 from *Fifteenth Census of the U. S., 1930*, Agriculture, vol. IV, ch. VII, tables 17–19, pp. 535–537; number of tractors for 1910 and 1935 from Eugene G. McKibben and R. Austin Griffin, *Changes in Farm Equipment; Tractors, Trucks, and Automobiles* (WPA, N.R.P. Report No. A–9) table B–1; number of autos on farms in 1910 estimated as equal to 2 percent of number of farms from *Ibid*, table E–6; number of autos in 1935 estimated as 2 percent greater than in 1930, see *Ibid*, p. 39. Trucks on farms: None counted for 1910; estimate for 1935 of 985,000 based on *Ibid*, p. 41. Approximate values were applied as follows: Tractors, 1910 and 1920 at $500, 1930, $400, 1935, $380; trucks, 1920, $350, 1930, $250, and 1935, $225; autos, 1910, $350, 1920, $300, 1930, $200, and 1935, $180. The 1930 estimated numbers of tractors, trucks, and autos were used for all periods in arriving at values at 1924–29 prices.

[3] Value at 1924–29 prices divided by numbers of farms for the years specified from Eldon E. Shaw and John A. Hopkins, *Trends in Employment in Agriculture*, (WPA, N. R. P. Report No. A–8) table B–1, pp. 113–15

[4] Value at 1924–29 prices divided by numbers of workers on farms for the years specified from Shaw and Hopkins, *op. cit.*, table 1, p. 11.

[4] *Agricultural Statistics, 1938* (U. S. Dept. Agr.), pp. 333, 444.

Whereas work stock has declined, the number of mechanical power units has increased. Thus, when values of work stock and mechanical power units are combined and valued at constant (1924–29) prices, it is found that total investment in prime movers on farms in 1935 was 58 percent greater than in 1910, and reflects a pronounced increase in available farm power.

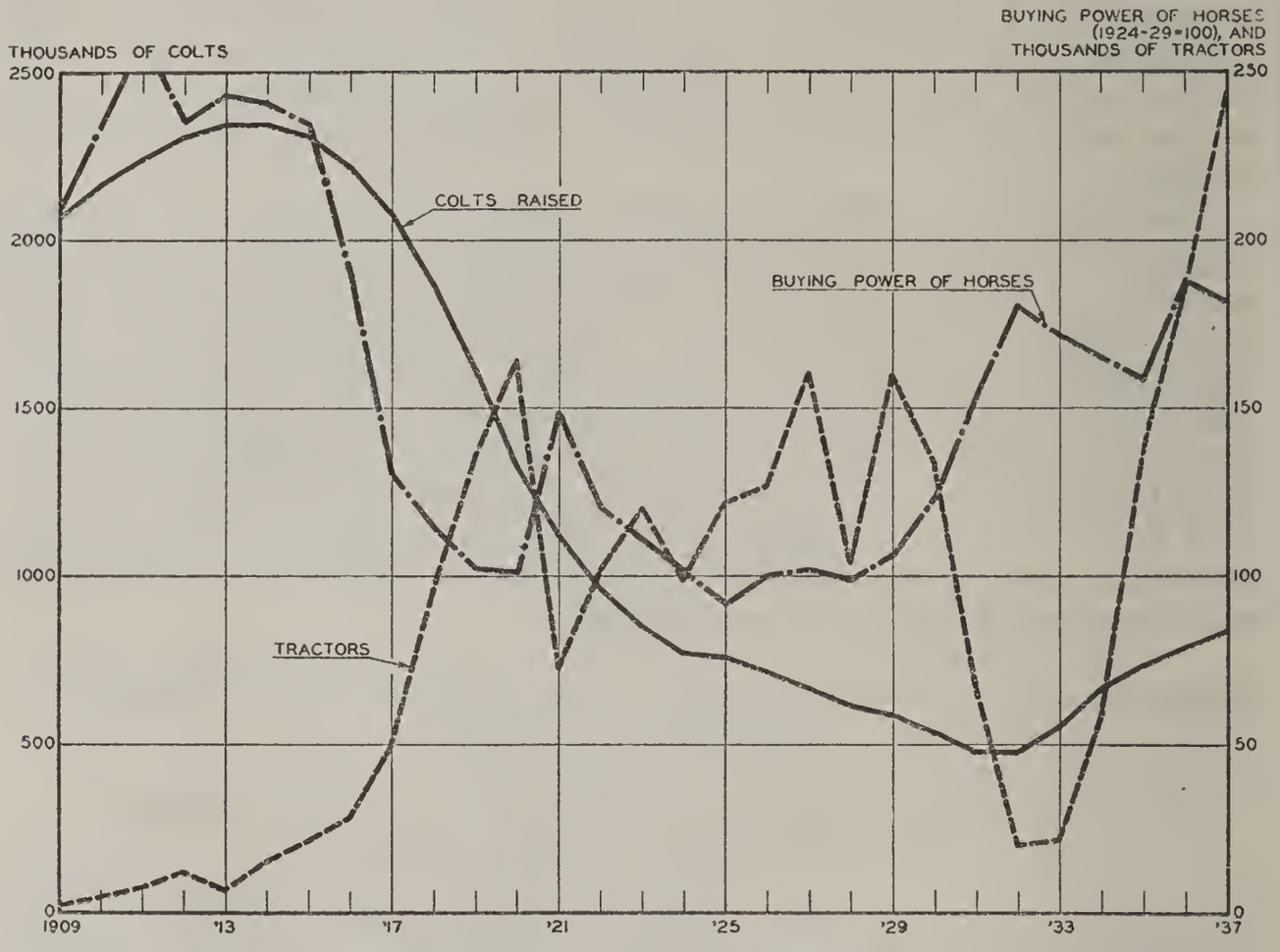

FIGURE 6.—Colts raised on farms, buying power of horses, and number of tractors sold in the United States, 1909–37.

TRENDS IN INVESTMENT IN LIVESTOCK

Livestock, other than horses and mules, were shown to comprise about one-third of the total valuation of capital goods on farms both in 1910 and in 1930, or about 10 percent of the total farm investment. The valuation of this livestock, at current prices, has varied widely since 1909. In that year it amounted to just under 2 billion dollars. By 1919 it had risen with wartime prices to almost 6 billions. This was followed by a sharp drop in 1921 and 1922, recovery until 1929 and 1930, and a new decline to the 1909 level in January 1934. The year-to-year changes are shown in figure 7.

The greater part of this fluctuation was caused by changes in prices. When the 1924–29 prices are used throughout the period (table 24) the investment in livestock per farm worker amounted to $308 in 1909–13, as compared with $376 in 1917–21. During the 1920's the figure changed only a little, but there was a further rise during the 1930's. Thus, the average farm worker in the last few years cared for over half again as much livestock (other than horses and mules) as in 1909. Further, the milk cows and some of the other stock were of greater productive capacity at the end than they were at the beginning of the period.

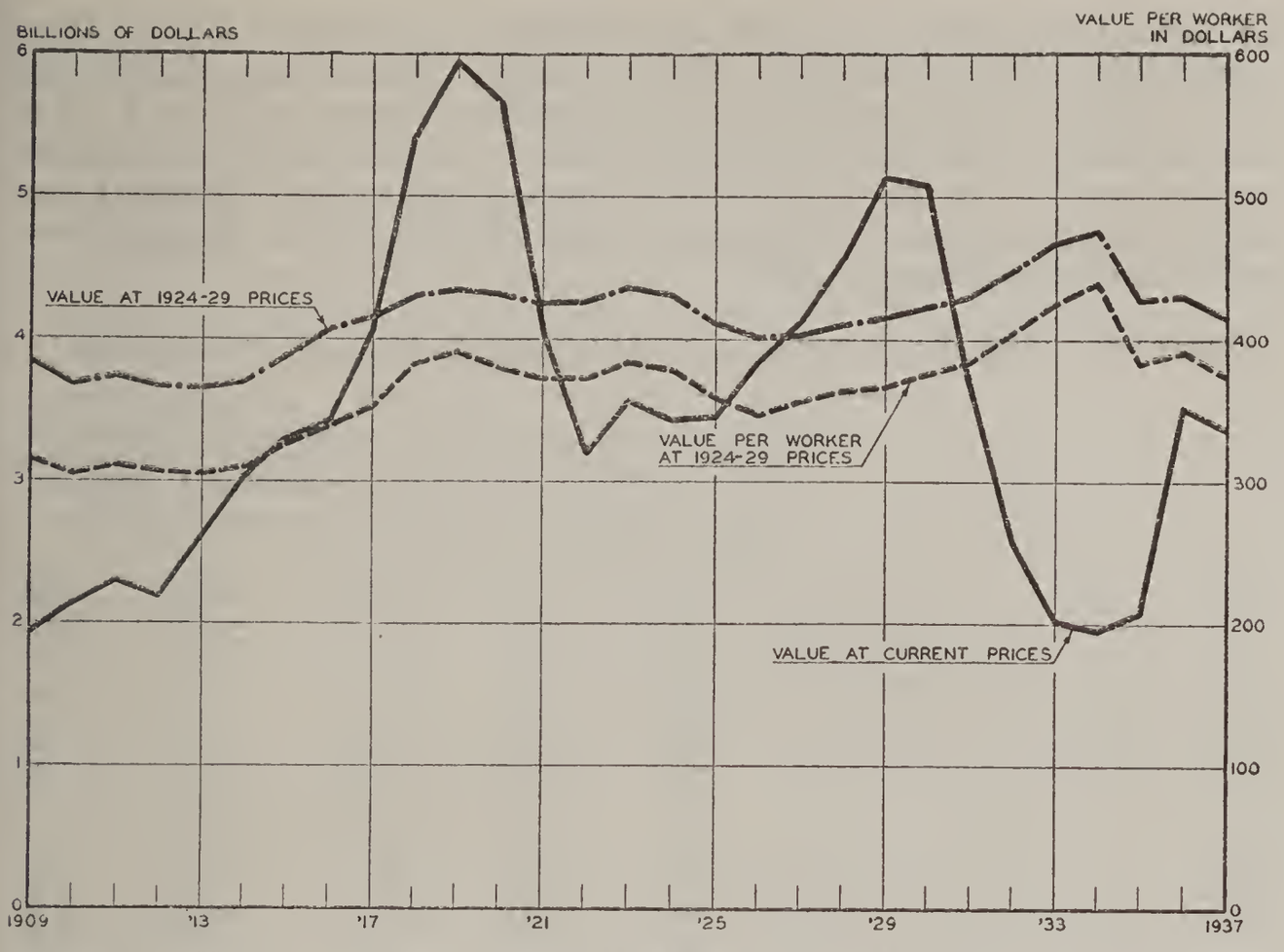

FIGURE 7.—Value of livestock other than work stock at current prices and at 1924–29 prices.

Source: *Agricultural Statistics, 1938.*

TABLE 24.—*Annual value of livestock in the United States, 1909–37* [1]

Year	Work stock			Other livestock		
	Value at current prices	Value at 1924–29 prices	Value per worker at 1924–29 prices	Value at current prices	Value at 1924–29 prices	Value per worker at 1924–29 prices
	Mil. dol.	*Mil. dol.*	*Dollars*	*Mil dol.*	*Mil. dol.*	*Dollars*
1909–13	2,744	1,687	140	2,232	3,720	308
1917–21	2,700	1,787	157	5,029	4,274	376
1922–26	1,676	1,624	142	3,496	4,208	368
1927–31	1,375	1,388	124	4,515	4,154	370
1932–36	1,251	1,197	109	2,421	4,503	409
1937–38	1,642	1,108	103	3,454	4,235	393

[1] Data for numbers of livestock and current prices from *Agricultural Statistics, 1937* (U. S. Dept. Agr.) pp. 244, 257, 270, 290, 293; number of chickens from R. G. Bressler and J. A. Hopkins, *Trends in Size and Production of the Aggregate Farm Enterprise* (WPA N. R. P. Report No. A-6, July 1938); chicken prices 1925–36 from *Agricultural Statistics, 1937*; 1909–24 estimated by multiplying price per pound (Yearbook of Agriculture, 1927, p. 1097) by 4.32, the ratio of price per pound to value per head, from *Agricultural Statistics, 1936*, p. 286; data for number of workers from Eldon E. Shaw and John A. Hopkins, *Trends in Employment in Agriculture* (WPA N. R. P. Report No. A-8); livestock numbers and current values for 1937–38 from *Agricultural Statistics, 1939*. Value per worker 1937–38 obtained by dividing indicated values by average number employed in agriculture from table 11, p. 17.

TRENDS IN PURCHASES OF FARM IMPLEMENTS

Expenditures of farmers for implements (other than tractors and engines) were about two and one-half times as great in 1920 as in 1909, when expressed in current dollars (table 25). There were sharp drops during the depression of 1921 and from 1931 to 1935. Otherwise, the general level of implement sales (excluding tractors and engines) did not differ greatly from 1919 to 1938. Prices per unit

of farm implements, however, rose sharply during the World War and fell but little thereafter. Consequently, when expressed in terms of the 1910–14 farm-machinery price level, as shown in figure 8, it is found that the volume of machinery sold for use in the United States at the end of the period was not much greater than reported for 1909. Furthermore, in 1936, sales were divided among about 6 percent more farms than in 1909.

TABLE 25.—*Value of farm equipment sold by manufacturers for domestic use* [1]

Year	Total	Tractors and engines	Total implements	Tillage and planting equipment	Harvesting and threshing machinery
	Mil. dol.	*Mil. dol.*	*Mil. dol.*	*Mil. dol.*	*Mil. dol.*
1904			[2] 112	[2] 42	[2] 38
1909			[3] 112	[3] 45	[3] 32
1914	123	[4] 16	[5] 107	[3] 45	[3] 31
1919	357	[4] 144	[6] 213	[3] 72	[3] 64
1920 [6]	471	186	285	97	85
1921 [7]	177	62	115	29	31
1922 [7]	223	60	163	27	40
1923 [7]	312	87	225	53	54
1924 [7]	278	83	195	48	47
1925 [7]	341	104	237	59	63
1926 [7]	365	115	250	79	67
1927 [7]	392	139	253	71	83
1928 [7]	403	130	273	80	88
1929 [7]	459	163	296	89	96
1930 [7]	381	138	243	79	75
1931 [7]	198	71	127	36	38
1932 [7]					
1933 [7]					
1934 [7]					
1935 [7]	303	133	170	51	55
1936 [7]	409	186	223	72	65
1937 [7]	507	232	275	89	89
1938	409	165	244	66	90

[1] Data for 1920 from H. R. Tolley and L. M. Church, *Manufacture and Sale of Farm Equipment in 1920.* (United States Department of Agriculture Circular 212, April 1922.) Data for 1921–31 from Bureau of the Census series *Manufacture and Sale of Farm Equipment,* data for 1935–38 from Bureau of the Census series, *Manufacture and Sale of Farm Equipment and Related Products.* (These series were discontinued from 1932–34.)

[2] From *Fourteenth Census of U. S., 1920,* vol. X, Manufactures, p. 933, figures represent total manufacture, including manufactures for export.

[3] Total manufactures from *Fourteenth Census of the United States, 1920,* vol. X, Manufactures, p. 933, less exports according to *Census of Manufactures, 1921,* p. 1132.

[4] From *Census of Manufactures, 1921,* pp. 1131, 1132, represent manufacture of tractors and traction engines, less exports.

[5] Total value of product of agricultural implements industry (*Fourteenth Census,* vol. X, Manufactures, p. 933) less value of tractors and engines from *Census of Manufactures, 1921,* p. 1131, and less exports of agricultural implements other then engines and tractors from *Census of Manufactures, 1921,* p. 1132.

[6] Total value of products of agricultural implements industry (*Fourteenth Census,* vol X, p. 933) less 46 million dollars, the value of tractors and engines manufactured in these same establishments as given on p. 932, and also less 46 million dollars exports of agricultural implements (excluding tractors and engines) from *Census of Manufactures, 1921,* p. 1132.

[7] Data for total sales from *Manufacture and Sale of Farm Equipment, 1931* (United States Bureau Census, 1932), minus export data from *Foreign Commerce and Navigation of the United States, 1931* (United States Bureau Foreign and Domestic Commerce 1932), pp. 168 ff.

Even though the total volume of sales in the more recent years was similar to that in 1909 and 1914 (after allowing for differences in prices) there were important changes in the types and sizes of many implements and a shift to new types. In 1909, sales of tillage and planting equipment were about 40 percent greater than those of harvesting and threshing machinery, while in 1937 the values of the two groups were equal. There was more change *within*

groups of equipment, however, than *among* groups.[5] Sales of grain binders and threshers declined materially after 1920, while sales of combines rose from a value one-tenth as great as the total of binders, headers, and separators in 1920, until they exceeded the value of the earlier types in 1929 (fig. 9).

Capacity of harvesting machinery sold has varied widely from year to year, but capacity in recent years has not exceeded that of the years before adoption of the tractor (table 26). This suggests that, for the country as a whole, sales have been primarily for normal replacement.

The question may be raised as to whether the shift to larger implements does not involve a larger investment. In most cases in which the larger machines are of similar design, the original purchase price is likely to be lower per foot of working width, although higher for the entire machine. Direct comparisons are often difficult to make. For instance, the price of a combined harvester-thresher cannot be compared directly to that of a grain binder. The combine is ordinarily used to harvest several times as many acres of grain as a binder. Also the use of a binder necessitates an investment in a thresher as well. The latter machine is, however, used on several farms, instead of one, and is operated over a longer working season than either the binder or the combine. In comparisons between horse- and tractor-drawn equipment it should be noted that the latter is usually more carefully and strongly made, so that it either lasts longer or is used over a greater total acreage of crop.

TABLE 26.—*Approximate capacity of small-grain harvesting equipment sold for use in United States for specified periods, 1899 to 1937*

Year	Wheat acreage[1]	Capacity[2]				
		Total	Self-rake reapers	Binders	Headers	Combines
	Mil. acres	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*
1899	52	9,701	359	9,342	----------	----------
1904	43	4,962	610	4,352	----------	----------
1909	44	5,917	583	5,171	----------	163
1914	56	9,266	570	8,615	----------	81
1919	74	7,858	84	6,219	837	718
1920–24	51	2,674	10	1,787	405	472
1925–29	63	5,955	6	1,837	259	3,853
1930–34	43	2,608	----------	674	----------	1,934
1935–37	68	6,139	----------	1,868	----------	4,271

[1] Acreage harvested for the years 1899 to 1919, and in the latest year named for each of the 5-year periods thereafter. The acreage harvested in 1899 represented a 12-million-acre increase over the figure of 1894. From Agricultural Statistics, 1937, pp. 9–10.

[2] Based on numbers of machines sold in specified periods from WPA N. R. P. Report No. A–10, *Changes in Technology and Labor Requirements in Crop Production—Wheat and Oats*, table D–1, p. 132; figures before 1920, however, represent total numbers manufactured. Approximate capacity in acres was obtained by multiplying numbers of reapers by 10, binders by 40, headers by 200, and combines by 200 for sizes under 10 feet and by 400 for sizes over 10 feet, or by 300 where numbers are not shown separately by sizes of combines. "Capacity" represents approximate acreage on which the specified machines are used on an average rather than the full acreage they are capable of harvesting.

[5] See N. R. P. Report No. A–11, *Changes in Farm Power and Equipment*, by Eugene G. McKibben and others for discussion of the changes in types and sizes of implements.

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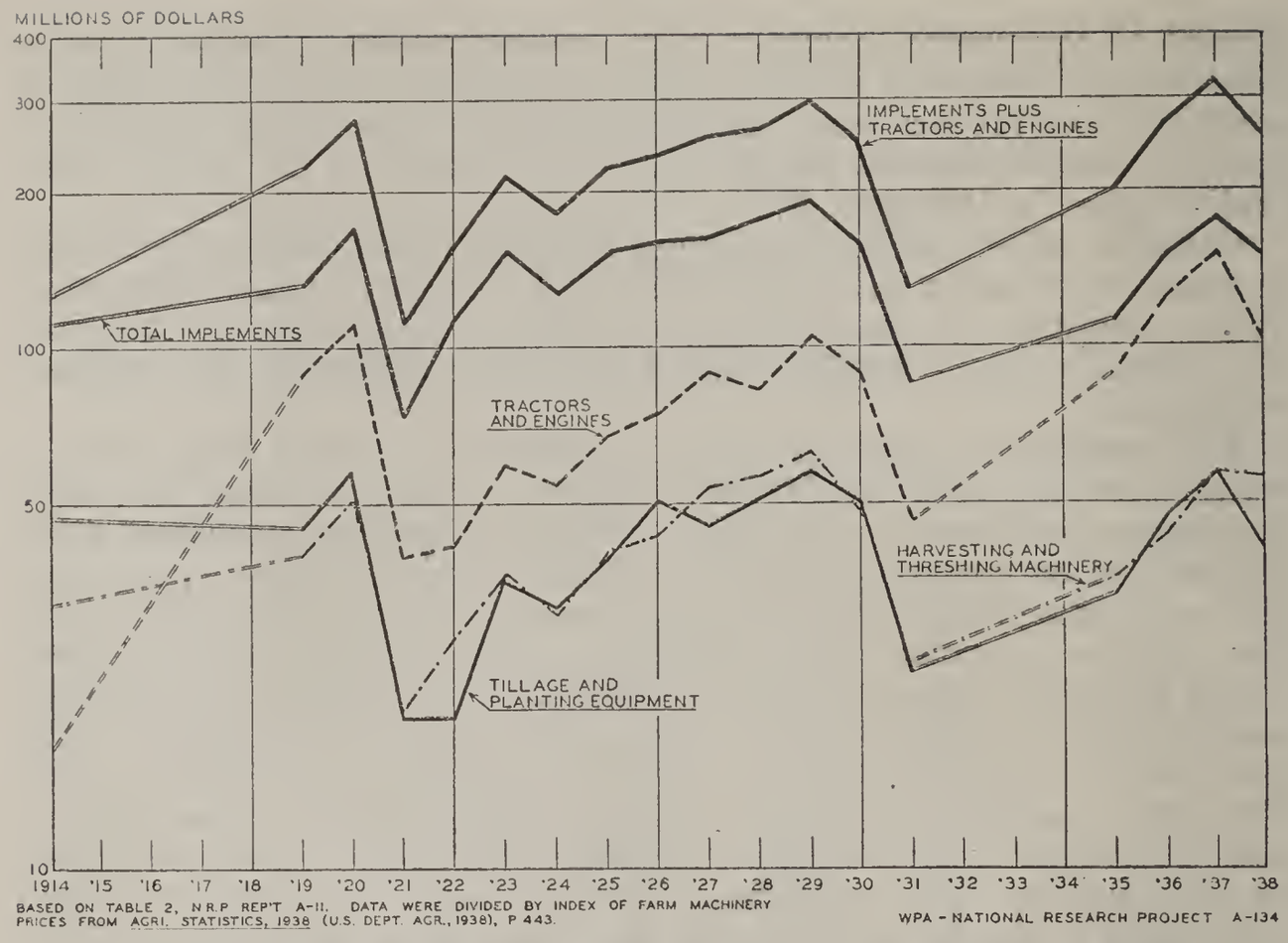

FIGURE 8.—Value, at 1910–14 prices, of farm machinery sold, 1914–37.

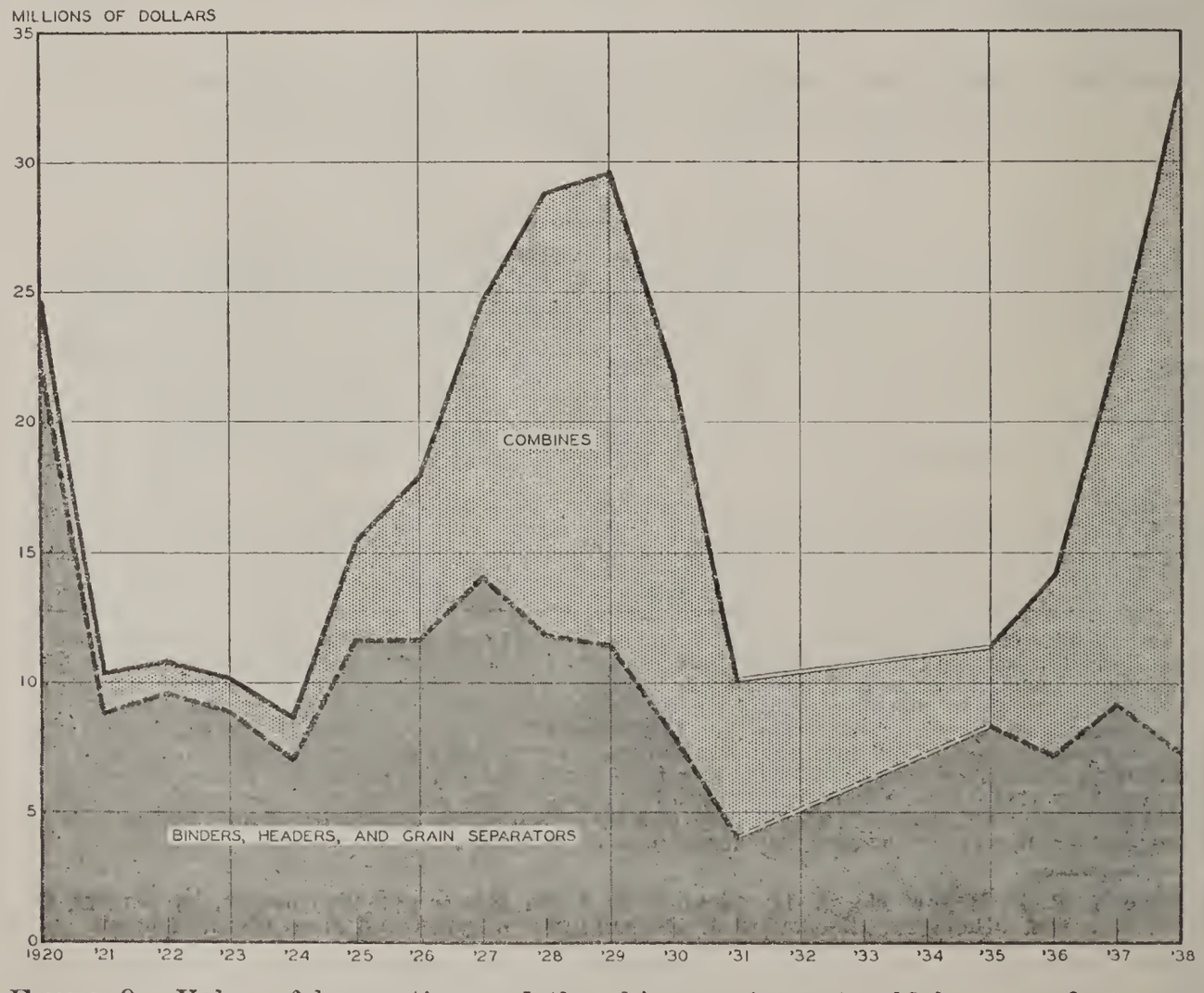

FIGURE 9.—Value of harvesting and threshing equipment sold by manufacturers for domestic use, at 1910–14 price level.

Source: Based on data divided by 1910–14 farm machinery price index from *Agricultural Statistics, 1938*, p. 399.

TRENDS IN THE FORMATION OF AGRICULTURAL CAPITAL

The fundamental phenomena of production of farm capital goods may be observed at various points in their creation although not expressed at any stage in financial figures. Available statistics permit only a rough measurement of these goods for recent years and are very incomplete for the first part of the period under study.

Capital Goods Produced on the Farm

Farm machinery and building material are purchased and paid for by the farmer, just as by the manufacturer. The farmer himself, however, may contribute a part of the labor in constructing buildings on his farm or he may use his teams in hauling materials. The farm may also furnish timber, stone, or sand. It is seldom possible to segregate the value of these additions to capital from operating expenses, particularly since many of them may represent the use of owned resources on which no market valuation is ever placed. It is even more true that the farmer makes a large part of his own capital when we consider the construction of fences, drains, and terraces. Fence posts are commonly produced on the farm where they are used. The farmer or his hired man constructs and repairs fences, terraces, ditches, and so on. There is no way of determining just what the value of this type of capital construction and maintenance amounts to, or what percentage of agricultural employment is spent on it. It seems a safe conclusion that the quantity of farm improvements of the home-made type increased to some extent between 1909 and 1929, but that it was not fully maintained from 1930 to 1935.

Capital goods in the form of livestock and of crops which are on hand, either awaiting sale or conversion into livestock products, also represent farm-produced capital. The amount of feed crops found on farms during the winter and spring depends chiefly on the size of the preceding harvest. There is no evidence that the proportion has changed otherwise, although the valuation fluctuates with prices. The value at current prices, of average stocks of corn, oats, wheat, and hay on farms on March 1 averaged 1,348 million dollars in 1926–29 as against 1,170 million in 1909–13.[6] At 1926–29 prices, however, the stocks for the 1909–13 period were worth 1,393 millions or very nearly the same as 15 years later. These March 1 stocks amounted to 33 percent of the specified crops in each period. But with the number of persons working on farms declining, there was a 10 percent increase in capital goods of this type when expressed per worker.

The investment in livestock other than work stock, however, underwent a definite expansion (table 27). When expressed per worker and at a standard price for all periods, it increased about $75 from 1910 to 1935. By far the greater part of the apparent change

[6] Estimated from *Yearbooks* of the Department of Agriculture and from *Crops and Markets* (monthly publication of U. S. D. A.) on the basis of figures given for stocks of corn, oats, and wheat, multiplied by the December 1 price for the years when grown. For hay it was assumed that 60 percent of the crop was still on farms on January 1, and 30 percent on March 1.

in livestock value shown in figure 7 was merely in the price. The figures at standard prices are the more significant, as they give an indication of changes in numbers rather than in valuations. The farmer's actual investment in cattle or horses is made in quantities of labor and feed rather than in money. There are livestock which have been bought from other farms. But the statement just made holds good for agriculture as a whole. This is one of the most important phases of the whole problem of farm-capital formation and maintenance. That is, it consists fundamentally, not in certain financial transactions, but in directing part of the labor and part of the physical product of the farm into increase of productive physical goods rather than into maintenance.

TABLE 27.—*Value of specified types of farm capital goods per worker at 1924–29 prices* [1]

Year	Buildings	Implements and machinery	Horses and mules	Other livestock
	Dollars	*Dollars*	*Dollars*	*Dollars*
1910	381	155	136	304
1920	358	290	157	380
1930	541	299	120	377
1935	537	234	105	383

[1] Values per worker in table 22 divided by B. A. E. index of prices of building materials for buildings other than houses: Index of prices of farm machinery, prices of horses and mules, and prices of other livestock, respectively, each converted to a 1924–29 base.

Our present question is whether, during the quarter century we are studying, farmers spent increasing amounts of labor, feed, and so on, to produce capital in the form of livestock; or whether they merely maintained such capital; or were actually able to liquidate it and spend the proceeds for other purposes. Actually, there were two distinct movements since the beginning of the period (table 24). From 1909–13 to 1917–21 an increase, as measured in 1924–29 dollars, amounted to 100 million dollars in work stock and 554 millions in other livestock. The two combined amounted to about $105 per farm, or required an accumulation of capital of about $10 per farm per year on an average, although this differed between areas.

From 1917–21 to 1932–36, on the contrary, there was a general shifting of capital to other forms than work stock, and a small decrease in other livestock, even though the number of farms increased 4 or 5 percent.[7] The result was that in this period of 17 years the average value of all livestock (at 1924–29 prices) declined by approximately $60 a farm or $4 a year.

PURCHASED FARM CAPITAL

Types of farm capital that are bought are easier to express in summary terms, although the statistics are neither complete nor very precise. Building materials and machinery make up an important fraction of the annual farm expenditures and can only be obtained

[7] E. E. Shaw and J. A. Hopkins, *Trends in Employment in Agriculture* (WPA N. R. P. Report No. A–8; November 1938), appendix B.

by purchase. Table 28, based on figures prepared by the Bureau of Agricultural Economics, shows the sharp change in capital expenditures that occur from normal or prosperous years to periods of agricultural depression.

TABLE 28.—*Changes in capital expenditures, 1924–29—1930–34*

Item	1924–29	1930–34
	Mil. dol.	*Mil. dol.*
Gross farm income	11,600	7,088
Purchases and repairs of machinery and tractors	417	214
Purchases of autos and trucks	305	155
Farm buildings and repairs	280	135
Total, specified capital expenditures	1,002	504
Percentage of gross income	8.6	7.2

It is a common opinion that farm buildings and equipment were improved and increased in physical quantity during the years 1924–29, a period in which capital expenditures averaged about 1 billion dollars per year. Buildings were generally maintained and additions made, while the stock of machinery and equipment on farms was increased by additional purchases. During the depression years 1930–34, when such expenditures averaged about 500 million dollars per year, no expenditures were being made if they could be avoided or deferred. Buildings and fences deteriorated and old machines were patched up to keep them running a little longer.

From 1909 to 1919 the purchase of implements and machines (including tractors, trucks, and automobiles) required around 4 percent of gross farm income (table 29). Its ratio to labor, however, increased from 6 percent of the value of labor in 1909–13 to 9 percent in 1917–21. This is explained partly by the decrease in amount of labor employed at the end of the war as compared to the beginning, and partly by the fact that purchases of automobiles and tractors were becoming more and more important. By 1927–31 the purchase and repair of machinery had climbed to 7 percent of gross farm income and was equal to 12 percent of the value of farm labor. It is probable that the expenditures for implements of the same type as those reported for 1909 accounted for only about 4 percent of the gross farm income, since 38 percent of the wholesale value of farm machinery sold by manufacturers for domestic use consisted of tractors and engines.[8] In addition, there were automobiles and trucks, sales of which amounted to very little in 1909–13, but which were included in the 7 percent of gross income spent for equipment in 1927–31.

With the purchase of automotive equipment, there came into existence a new expense for its operation. This expense took less than one-half of 1 percent of the gross income in 1909–13, but amounted to 4 percent in 1927–31. Following 1929 this expense declined less than did gross income and the percentage of income required to cover it actually increased. These figures are of interest as an indication of the increased

[8] This is based on figures from *Manufacture and Sale of Farm Equipment and Related Products, 1929*, U. S. Bureau of the Census. Sales of these manufacturers of materials other than farm equipment were omitted from the total in computing this percentage.

commercialization of farming. The farmer has become more dependent on other industries for the operation of his farm as well as for equipping it.

TABLE 29.—*Gross farm income and percentage distribution of specified classes of capital expenditures, 1909–35*

Year	Gross farm income [1]	Percentage gross income spent for—			Value all labor as percentage of gross income [2]	Capital expenses as percentage value all labor		
		Wages hired labor [1]	Implements and automotive equipment [1]			Implements and automotive equipment		Equipment purchase plus building repairs [3] [4]
			Purchase and repair	Operation		Purchase and repair [3]	Purchase and operation [4]	
	Mil. dol.	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1909–13	6,694	10	4	([5])	58	6	7	----------
1917–21	13,472	9	4	2	48	9	13	----------
1922–26	11,154	10	5	3	52	10	16	----------
1927–31	10,344	10	7	4	54	12	20	16
1932–35	6,882	7	5	6	47	10	23	14

[1] *Agricultural Statistics, 1938* (U. S. Dept. Agr.,1938), p. 434. Only farm share of cost of operation of autos is included.

[2] Wages of hired labor plus value of family labor calculated as follows: Number of family workers from Eldon E. Shaw and John A. Hopkins, *Trends in Employment in Agriculture* (WPA N. R. P., Report No. A-8, November 1938) p. 11, multiplied by yearly wage of farm labor without board, from *Agricultural Statistics 1938*, table 572, p. 450 (monthly wage multiplied by 12); data for 1924–28 derived from *Crops and Markets*, vol. 10, no. 4 (April 1933), p. 145; data for 1929–31 derived from *Crops and Markets*, vol. 12, no. 7 (July 1935), p. 271; data for 1932–35 derived from *Income from Farm Production in the United States* (U. S. Dept. Agr., Bur. Agr. Econ. September 1936), p. 8. [mimeographed.]

[3] Basic data for columns (3) plus (4) divided by basic data for column (5).

[4] Basic data for column (3) divided by basic data for column (5).

[5] Less than 0.5 percent.

Additional amounts are spent for replacements and repairs of buildings and other improvements. Figures on these items are available only since 1924. From 2.0 to 2.5 percent of gross farm income was required for this purpose except during 1932–34 when it fell to about 1.5 percent. When building repairs are added to the equipment expense, the indicated outlays for capital maintenance were equal to 16 percent of the value of farm labor in 1927–31 and 14 percent in 1932–35 (table 29).

A rough approximation to the change in physical capital may be obtained by dividing the valuation of buildings and of equipment from the Census by the indexes of prices paid by farmers for purchases of goods of these types in the years indicated.[9]

Values of farm buildings per farm by census periods since 1910, when taken at 1924–29 prices, are as follows: 1910, $726; 1920, $630; 1930, $962. In other words building deteriorated during the decade of the War of 1914–18 by amounts which would probably require about $10 per year to repair. During the 1920's, on the contrary, buildings were improved by amounts equal to about $33 per farm per year.

[9] It should be kept in mind that the resulting figures are very rough approximations only. As was pointed out on a previous page, the valuation placed by farmers on their resources at any given date is partly subjective and depends on the outlook for farm income. Their valuations therefore do not vary exactly with the prices paid for new equipment or for new construction. The disparity between the two sets of data are likely to be greatest with regard to buildings. The index used relates to materials purchased for construction of buildings other than dwellings, and therefore does not take into account wages and other construction costs. However, it should be said that wages paid by farmers for such construction work as is hired is generally below wages paid for similar work in cities.

The greatest increase in buildings between 1910 and 1930 occurred in the western dairy and the northwestern areas, both of which were in a stage of development. The smallest improvements occurred in the delta and the eastern cotton areas (table 30).

TABLE 30.—*Approximate value of buildings and implements per farm as (percentages of 1930) at 1924–29 prices*

Area	Buildings [1]			Implements and machinery [2]		
	1910	1920	1930	1910	1920	1930
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
United States	75	65	100	56	97	100
Corn	70	65	100	54	107	100
Eastern dairy	75	65	100	53	77	100
Western dairy	66	59	100	50	89	100
Middle eastern	72	63	100	68	106	100
Eastern cotton	79	80	100	81	136	100
Delta cotton	88	82	100	90	114	100
Western cotton	72	73	100	52	86	100
Small grain	72	69	100	46	89	100
Range	68	63	100	45	84	100
Northwestern	66	61	100	56	98	100
California	73	57	100	60	105	100

[1] Average values of buildings per farm were divided by indexes of prices of building materials for farm buildings, other than houses, as given in Agricultural Statistics, 1938, p. 443, reduced to a 1924–29 base. The resulting values were then expressed as percentages of the 1930 figure.

[2] Computed as for buildings except that indexes of prices of farm equipment from Agricultural Statistics, 1938, p. 443, were used to obtain values on a 1924–29 base.

Valuations of implements and machinery (including tractors, trucks, and automobiles) per farm at 1924–29 prices were: 1910, $297; 1920, $512; 1930, $530. This again brings out the pronounced increase in machinery between 1910 and 1920, although the figures as given may overstate the change in this decade. The greatest increases in equipment per farm occurred in the small-grain and the range areas and the smallest were in the delta and eastern cotton areas, where they amounted to only $15 and $25 per farm, respectively, from 1910 to 1930. In the middle eastern area the increase was $64 per farm. In the small-grain area where the greatest amount of mechanization occurred, the increase was $664, in 1924–29 dollars, and the 1930 figure was $1,219. In the other areas the increases amounted to $350 to $450, in round numbers. Again, it should be kept in mind that these figures include increases in automotive equipment as well as in implements.

If the increase of $233 per farm for all farm equipment between 1910 and 1930 is multiplied by the number of farms in 1930, a total of just under 1.5 billion dollars is obtained. This does not differ greatly from the increase in valuation of farm automotive equipment which was shown in table 23. Although both of these sets of figures are obviously very rough, they serve to emphasize again the fact that the principal change was in the adoption of automotive equipment and that there was very little change in the total amount of implements as contrasted to prime movers.

To summarize: Relatively little of the increase in production per agricultural worker can be attributed merely to a greater quantity of capital either per worker or per farm. Although there were more livestock other than work stock and more buildings in some areas, the most important change as affects labor productivity was in power

units and implements, and here the really significant change was in the form rather than the amount. The change in valuation of implements was shown to consist largely in an increase in tractors, trucks, and autos. A large part of this was offset by the decline in work animals. For the average farm, the total value of prime movers at 1924–29 prices was only about $165 greater in 1930 than in 1910, but this has been the change in capital goods which has had the greatest effect on the productivity of farm labor.

When the principal types of capital goods are expressed in values per worker at 1924–29 prices, however, increases in each of the principal types of resources except work animals are found. Thus, it was shown in table 27 that the valuation of farm buildings for each worker was $160 greater in 1930 than in 1910. The corresponding increase for implements and machinery was $144, while for livestock other than horses and mules it was $73. When tractors, trucks, and automobiles are separated from the other machinery and added to the work stock, however, we find that the value of all prime movers per worker increased by $106 from 1910 to 1930. Whereas this was not so very large in absolute dollars it was 75 percent more than the 1910 figure. On the other hand, this increase did not amount to over 10 percent of the total value of the combined types of capital goods just discussed and, furthermore, it included the automobiles which are used about as much for personal purposes as for farm business. The changes in form will be explained more at length in the next three chapters, which discuss the mechanization and changes in techniques and labor requirements in the production of crops and livestock.

CHAPTER V. MECHANIZATION IN AGRICULTURE[1]

The most important influence on agricultural employment since 1909 has been the adoption of mechanical power and the use of more and larger mechanical appliances. The general process may be discussed conveniently under four headings: The adoption of tractors for field motive power, the use of automobiles and trucks for transportation, the resulting reduction in numbers of horses and mules on farms, and the development of improved and larger farm implements.

Farm mechanization and its consequences have affected both farm and city dwellers. On farms larger implements, operated at greater speeds, have made it possible to grow crops with an expenditure of much less labor than previously. Partly offsetting this saving in labor there has been increased employment in the urban industries which manufacture automobiles, tractors, or implements, and those which service them or produce fuel, tires, and other supplies. Of equal or greater importance, the reduction in number of horses meant that a large amount of land, formerly used to grow horse feed, could be devoted to production of milk or meat. This chapter will describe the principal forms taken by farm mechanization, and will evaluate their principal effects on employment.

ECONOMIC INFLUENCES ON MECHANIZATION

Mechanical improvements have greatly strengthened the competitive position of farm implements, and of tractors, trucks, and automobiles, as compared with labor. But technical improvements alone cannot explain the degree of change nor the timing of the successive waves of machine adoption. Economic forces have played a leading role also by modifying the relative prices of farm labor, implements, and products.

A wide range of choice obtains between combinations of the various factors of production. The precise combination that farm operators tend to use under a given set of physical conditions depends on the values of the various factors per unit of use. As applied to implements, these values include interest, repairs, depreciation, and operating costs per unit of work done. The volume of production depends on the schedule of demand for the various farm products and, on the other side, on the principle of diminishing returns in the presence of competing bids for the variable cost factors.

The available amount of farm land of each grade is relatively fixed, and the supply of capital goods changes only slowly with the

[1] This chapter is based chiefly on data published in WPA N. R. P. Report No. A–9, *Tractors, Trucks, and Automobiles,* by Eugene G. McKibben and R. Austin Griffin, and N. R. P. Report No. A–11, *Field Implements,* by Eugene G. McKibben, John A. Hopkins, and R. Austin Griffin. Some data have also been drawn from N. R. P. Reports Nos. A–5, A–7, and A–10, on *Changes in Technology and Labor Requirements in Crop Production; Corn, Cotton, and Wheat and Oats,* respectively; and from various other sources.

wearing out or demolition of old machinery and buildings on the one hand, and the addition of new equipment or improvements on the other. The amount of farm labor used at any time is determined partly by the price of farm products, and partly on competitive bids of other industries for the same labor, as well as on the cost of machinery. The amount of farm machinery will consequently depend both on its physical performance, and on its value as compared to the values of farm products, and to the competing value of labor. As these values change, so will the extent to which use is made of machinery.

Relationships existing between prices of farm implements, farm labor, and farm products before the World War ended in 1915 and the value relationships have fluctuated widely since that time (fig. 10). During the war the prices of farm products rose more rapidly than wages, while implement prices lagged behind both. In that period, much of the manpower of the country was drawn away from farming and other peacetime occupations into the army or into munitions works; the remaining men commanded relatively high wages. But rising prices of farm products stimulated farm production, and there was a rapid adoption of new or larger implements in an effort to minimize outlays for labor. From 1920 to 1930, prices of farm commodities were on a level definitely lower than in the pre-war relationship with wages and farm implements, whereas wages remained relatively higher than machinery. Part of the reduction in prices of the products undoubtedly was attributable either to a lowering of cost

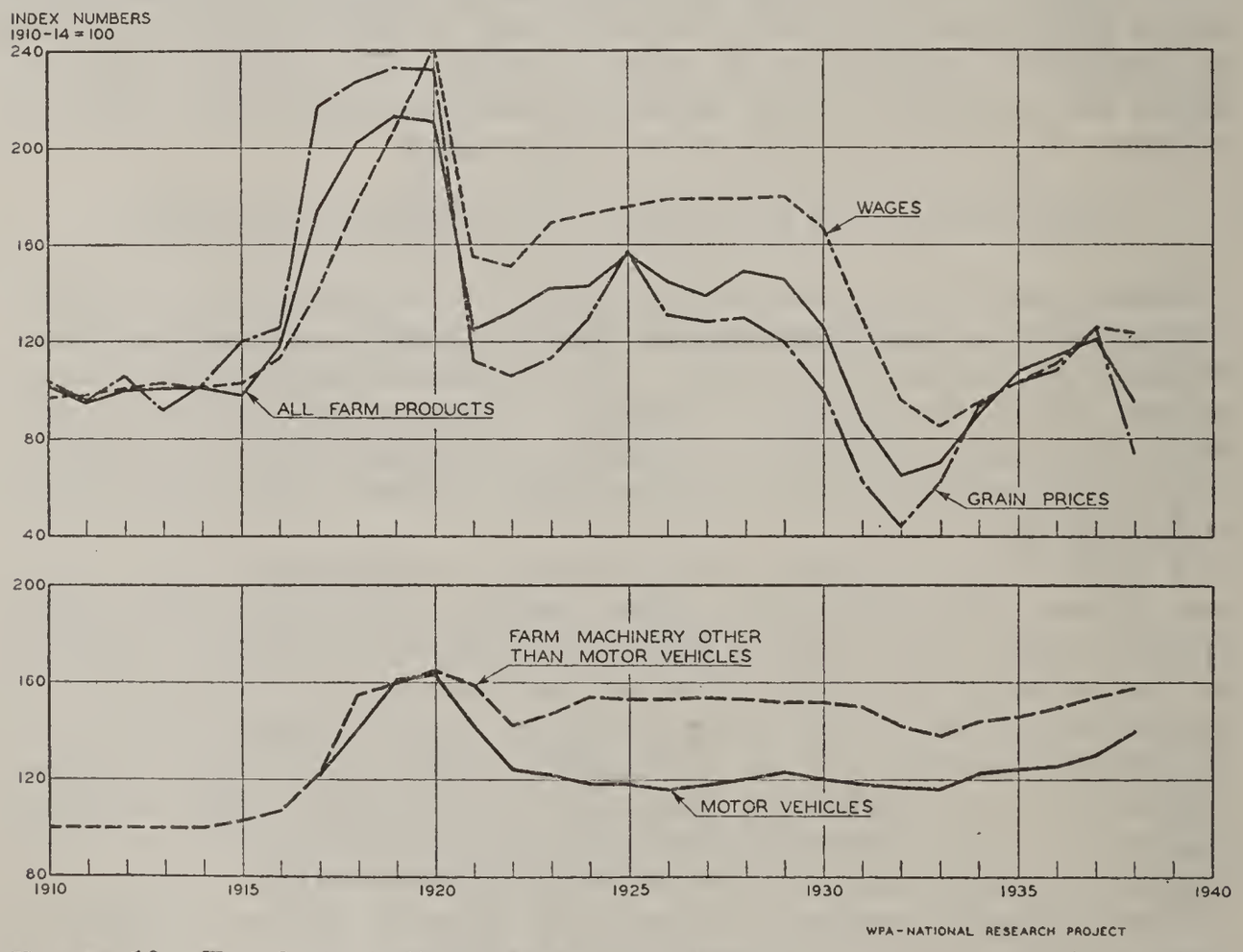

FIGURE 10.—Trends in indices of prices of farm implements, hired labor, and farm products, 1910–38.

Source: U. S. Dept. of Agriculture, Bureau of Agricultural Economics, *Income Parity for Agriculture*, pt. III, Prices Paid by Farmers for Commodities and Services, sec. 5, Index Numbers of Prices Paid by Farmers for Commodities, 1910–38 (preliminary). May 1939, pp. 12–13 [processed]; *Agricultural Statistics, 1939*, p. 497 and p. 506.

caused by technological improvements or to the expansion of output, which was itself partly caused by the same influences.

After 1930, the relationship between farm wages and machinery prices was reversed; the prices of farm machinery fluctuate only a little from year to year. With prices of farm products falling sharply and with a large supply of available labor backed up on the farms, there was little incentive to adopt new machinery, unless it represented a pronounced mechanical improvement over that previously available.

The shift to mechanical sources of power was subject to the same general influences as adoption of implements. To the prices of competing specialized cost factors in this case should be added a comparison between the prices of tractors or automobiles and of horses, and the technological considerations are concerned primarily with the relative advantages of horses or mechanical sources of power in transportation or in drawing field implements. As it became better adapted to farm work, and particularly with the development of the row-crop type, the tractor could be used for more farm operations. As the hours of tractor use per year increased, the cost per hour fell in relation to the cost of power. The economic advantage thus was closely connected with the mechanical improvement.

ADOPTION OF FARM TRACTORS

Adoption of farm tractors having internal combustion engines very nearly corresponds to the period under consideration. In 1910, it is estimated, only 10,000 of such tractors were used on the farms of the country, while in 1939 there were about 1⅓ millions, or more than 1 for each 5 farms. The period of rapid application of tractor power, as shown in figure 11, did not begin until 1918, under the stimulation of

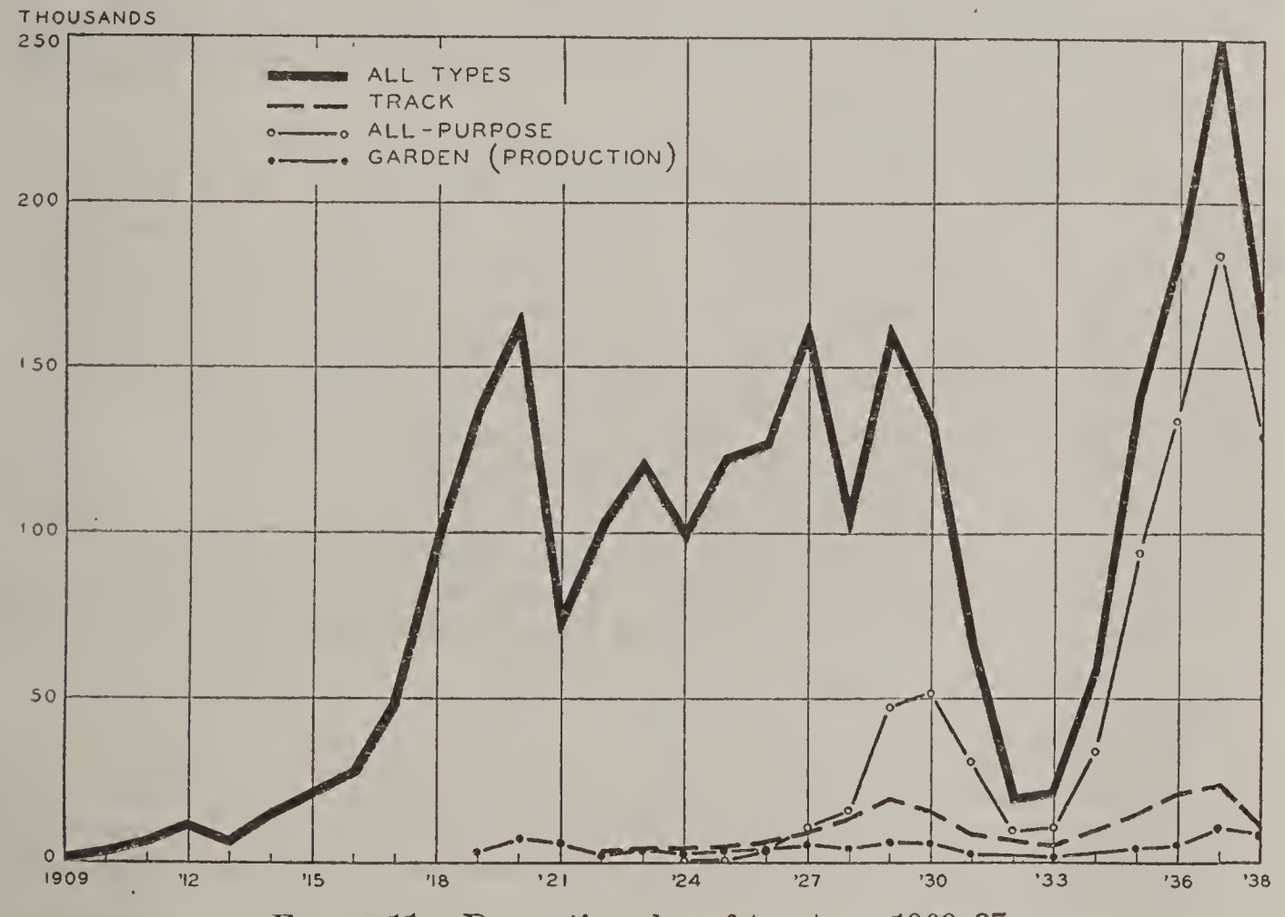

FIGURE 11.—Domestic sales of tractors, 1909–37.

Source: Based on table B–1, *Changes in Farm Power and Equipment: Tractors, Trucks, and Automobiles*, WPA N. R. P. Report No. A–9.

scarce farm labor and high wages during the European war. This phase of adoption related to the "standard" four-wheel type. A second phase began in the middle of the 1920's, when a light "all-purpose," or row-crop type became available and permitted general use of the tractor in cultivating intertilled crops.

Since 1909 improvement of tractors has been almost continuous and has had four principal objectives: (1) increased adaptability to farm work, (2) increased operating speeds, (3) greater mechanical dependability, and (4) reduced cost of operation. The improvement achieved rested on a large number of changes rather than on a few outstanding and dramatic ones. It was necessary to modify many elements of the machine including ignition systems, governors, fuel injection, cooling systems, bearings, and transmission. Thus, the modern tractor is a far better piece of machinery than tractors of the decade before 1920.

Development of the General-Purpose Tractor

Among the most important and spectacular major developments were those related to changes in the chassis design and in size of tractor. Most of the tractors sold for farm use before 1925 were of the four-wheel, or "standard" type, but there had been general adoption of the track type in certain areas and even limited sale of three-wheeled all-purpose tractors. The most important change in chassis design occurred with the development of the all-purpose tractor which, because of its wide tread and high clearance, could be used in cultivating row crops as well as in seedbed preparation. Earlier attempts had been made in this direction but a successful tractor of this type did not become generally available until 1924. At about the same time implements especially designed to attach to the tractor were also made available. These greatly increased the effectiveness of the outfits over the earlier ones which towed implements originally intended to be horse-drawn.

More effort was made to develop a range in size of tractors to fit the needs of the various sizes and types of farms. Most early all-purpose tractors were designed to draw two plows, but there were also three-plow tractors, both of the general-purpose and the standard type for larger crop acreages, one-plow tractors for small farms, and several types and sizes of garden tractors, for use on closely spaced truck crops. Since about 1935, one-plow tractors for use on small farms have increased rapidly in number. During the 1920's tractors were considered uneconomical on general farms of much under 200 acres. The development of small tractors greatly reduces the minimum size of farm that can use a tractor economically.

The potential importance of this statement may be emphasized by the following figures, from the 1935 Census of Agriculture, on numbers of thousands of farms, by size of farm:

Under 20 acres	1,254
20 to 49 acres	1,440
50 to 99 acres	1,444
100 to 174 acres	1,404
175 to 259 acres	540
260 to 499 acres	473
500 acres and over	256

The rate and extent to which the use of tractors will continue to spread to smaller farms depends largely on the relative costs of making, selling, and operating tractors or raising and working horses.

Among recent improvements for tractors are the power take-off, the power-lift, and low-pressure pneumatic tires. The power take-off permits the connection of the tractor engine to the mechanism of tractor-drawn implements and greatly increases the mechanical efficiency of an implement over one that is operated from a traction wheel drawn along the ground. It has made practical machines of such implements as the mechanical corn picker, the small combine, and the field ensilage cutter. The power-lift saves time and energy of the operator by utilizing the power of the tractor to lift the plow or cultivator out of the soil, in turning at the end of rows.

Low-pressure pneumatic tires designed for use on tractors became available in 1932. A survey by the Bureau of the Census showed that 14 percent of the wheel tractors produced in 1935 were equipped with pneumatic tires; by 1938, 68 percent of new tractors were so equipped. Tractors with these tires use less fuel and depreciate less rapidly than other tractors. Another important result is that tractors with rubber tires may be used for highway transportation, whereas under many conditions a steel-tired tractor cannot, but the rubber tires add to the original cost and about offset purely monetary savings in operation.

The Rate of Acceptance of the Tractor Since 1909

Between 1915 and 1921, the estimated number of farm tractors increased from 25,000 to 350,000. This expansion was influenced by labor shortage and wartime prices of farm products. Sharp drops in sales occurred during the depression of 1921, but this was followed by conditions favorable to adoption during the remainder of the 1920's: Generally satisfactory farm income, strong prices both for horse feed and for labor, and continued improvement in the tractor itself. During the early 1930's, sales fell off again and, further, the low prices of horse feed as compared to tractor fuel resulted in many tractors standing idle for a couple of years. With returning farm prosperity, this decline also was followed by record-breaking sales beginning in 1935.

The economic advantage of the standard tractor over horses changed but little from 1920 to 1937 as shown by a comparison of various studies made in the Corn Belt (table 31). Most of the two-plow standard tractors delivered 10 to 20 horsepower at the drawbar, but cost of operation, plus depreciation and interest on investment, was only 5 to 8 times more than the cost per hour of a horse. On larger farms, therefore, the standard type of tractor had considerable advantage in cost per horsepower hour on tasks requiring power units of 5 or more horsepower.

On most Corn Belt farms a limitation in the use of this type of tractor derived from the fact that (if we omit the cultivation of row crops), there was relatively little work requiring so much power, and the standard type of tractor was poorly adapted to use in cultivation. The average standard tractor was used about 300 hours a year for plow-

ing, disking and a few other field operations, and some belt work in filling silos, threshing, grinding feed, and so on.

Development of the row-crop or general-purpose type meant that the tractor could be used in cultivation. As a result, the number of hours of use per year was augmented by 50 percent to 100 percent. The hour cost for depreciation and interest on investment was reduced almost in proportion, and the total cost per hour declined from 4.4 to 6.3 times the cost of an hour of horse work, according to the more recent studies. This drop in relative cost of tractor, as compared to horse work, has been the deciding factor of adoption on many farms since 1925.

TABLE 31.—*Comparison of horse and two-plow tractor costs per year and per hour of use in Corn Belt*

Area	Year	Number horse-hours to equal cost of 1 tractor hour	Tractors					Horses					Source of data
			Type	Number of records	Hours use per year	Cost per year	Cost per hour	Number of records	Work horses per farm	Hours worked per year	Net cost per year	Cost per hour	
		Hours		*Number*	*Hours*	*Dollars*	*Dollars*	*Number*	*Number*	*Hours*	*Dollars*	*Cents*	
Ohio, Illinois, Indiana	1920	5.2	Standard	174	323	341	1.27	286	6.8	686	159	0.243	1
Corn Belt	1929	5.8	do	156	301	242	.80	[1] 343	6.0	688	96	.139	2
		4.4	General	79	471	288	.61						
Illinois	1931	6.6	Standard	32	383	214	.63	[1] 35	8.2	652	62	.096	3
		5.8	General	65	514	287	.56						
Indiana	1925–27	8.3	Standard	122	241	205	.85	[1] 149	7.2	819	84	.102	4
Iowa	1925–27	7.4	do	30	303	282	.93	62	6.2	869	92	.126	5
Iowa	1937	5.9	do	66	307	193	.63	[1] 49	5.0	802	86	.107	6
		5.0	General, steel tires	73	619	329	.53						
		4.7	General, rubber tires	61	783	389	.50						
Missouri	1930	7.9	Standard	11	258	183	.71	66	5.8	750	67	.090	7
		6.3	General	8	436	249	.57						

[1] On ordinary horse farms only.

Source of data:
1. U. S. D. A. Bulletin 997. *Cost and Utilization of Power on Farms Where Tractors Are Owned*, by H. R. Tolley and L. A. Reynoldson, 1921, pp. 2–4, 15, 44–55.
2. U. S. D. A. Technical Bulletin 384. *Utilization and Cost of Power on Corn Belt Farms*, by L. A. Reynoldson et al., 1933, pp. 16–17, 28–29, 39.
3. Illinois Bulletin 395. *Horse and Tractor Costs on Illinois Farms*, by R. E. Johnson and J. E. Wills, 1933, pp. 317, 323.
4. Indiana Bulletin No. 332. *Relation of Farm Power and Farm Organization in Central Indiana*, by O. G. Lloyd and L. G. Hobson, 1929, pp. 7, 30–36.
5. Iowa Bulletin No. 264. *Horses, Tractors, and Farm Equipment*, by J. A. Hopkins, 1929, pp. 377–85.
6. Iowa Research Bulletin No. 258. *Cost an Utilization of Power and Labor on Iowa Farms*, by Wylie D. Goodsell, 1939, pp. 326, 330, tables 2, 3.
7. Missouri Research Bulletin 197. *Power, Labor and Machine Costs in Crop Production, Linn Co., 1930*, by D. D. Smith and M. M. Jones, 1933, pp. 5–12.

It has been stated earlier in the report that the limitation on total size of most types of farms is set by the increasing difficulty of maintaining labor efficiency as the farm grows larger. Development of the farm tractor thus meant much more than an opportunity to reduce the cost of motive power. It opened three opportunities for changing the internal organization of the farm: It permitted the enlargement of crop acreage, without a corresponding increase in amount of labor employed; it reduced the amount of labor employed on larger farms, where the crop acreage was previously greater than could be handled by the farmer himself, and it became economically possible to raise crops on some lands previously submarginal because of low yields.

Of these factors, the first hitherto has been the least important. It is true that the acreage of some farms has increased, but evidence of any pronounced drift toward farm consolidation comes only from limited areas, and some opposing tendencies have been noted.

The second alternative, displacement of labor from farms adopting tractors, has been of greater consequence, and appears to be one of the most important causes of the changing ratios between amount of labor employed and size of enterprise. The effect is clearly shown by smaller employment in such farm operations as the harvesting of small grain in the West and harvesting of corn in the corn area.

Development of large-capacity tractor equipment has been the foremost cause of the extension of the small grain belt westward into semiarid sections where low yield formerly prevented crop production, and the extension of cotton production into the High Plains area in Texas and Oklahoma. By far the greater part of the increase in crop acreage from 1919 to 1929 was in these western areas, in each of which there is some extensive farming with horses, but with the tractor as the outstanding source of power (fig. 12). The

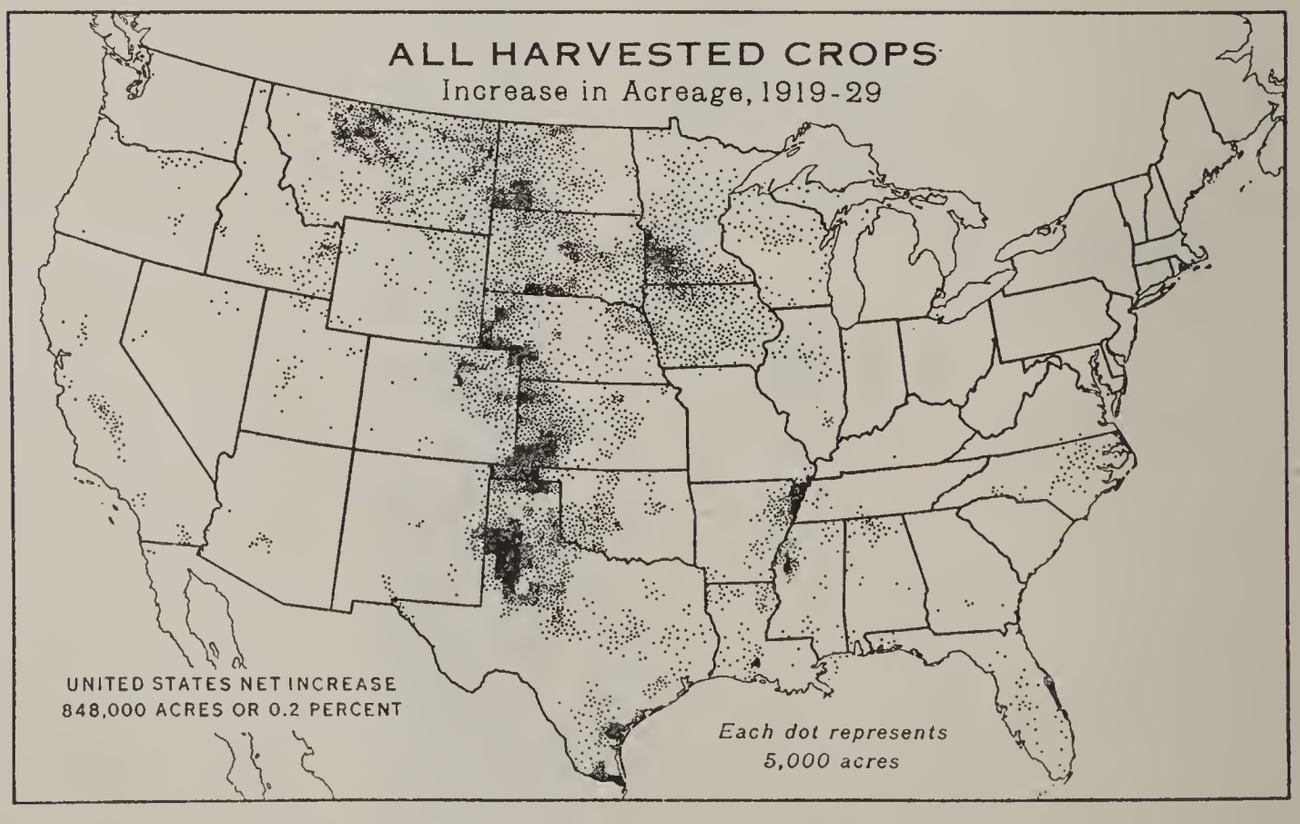

FIGURE 12.—Increase in crop acreage 1919–29.

Source: Bureau of Agricultural Economics.

relative advantages to be gained from the three types of application just discussed help to explain why tractors have been adopted so much more rapidly in some areas than in others.

Graphic Distribution of Tractors

Small, light-weight, two-plow tractors had become well-established in the Corn Belt and in the eastern edge of the small-grain area by 1920. There were but few tractors in the New England States, in the South, or in the sparsely settled range area, although areas of concentration occurred in New York, Pennsylvania, and California. The 1925 Census of Agriculture showed a general increase in numbers throughout the country, particularly in fruit and truck sections, such as Long Island, western New York, southeastern Pennsylvania, and California, and also in the western parts of the small-grain area. By 1930, a further increase had occurred, particularly in the corn area, attributable largely to development of the general-purpose or row-crop tractor (fig. 13).

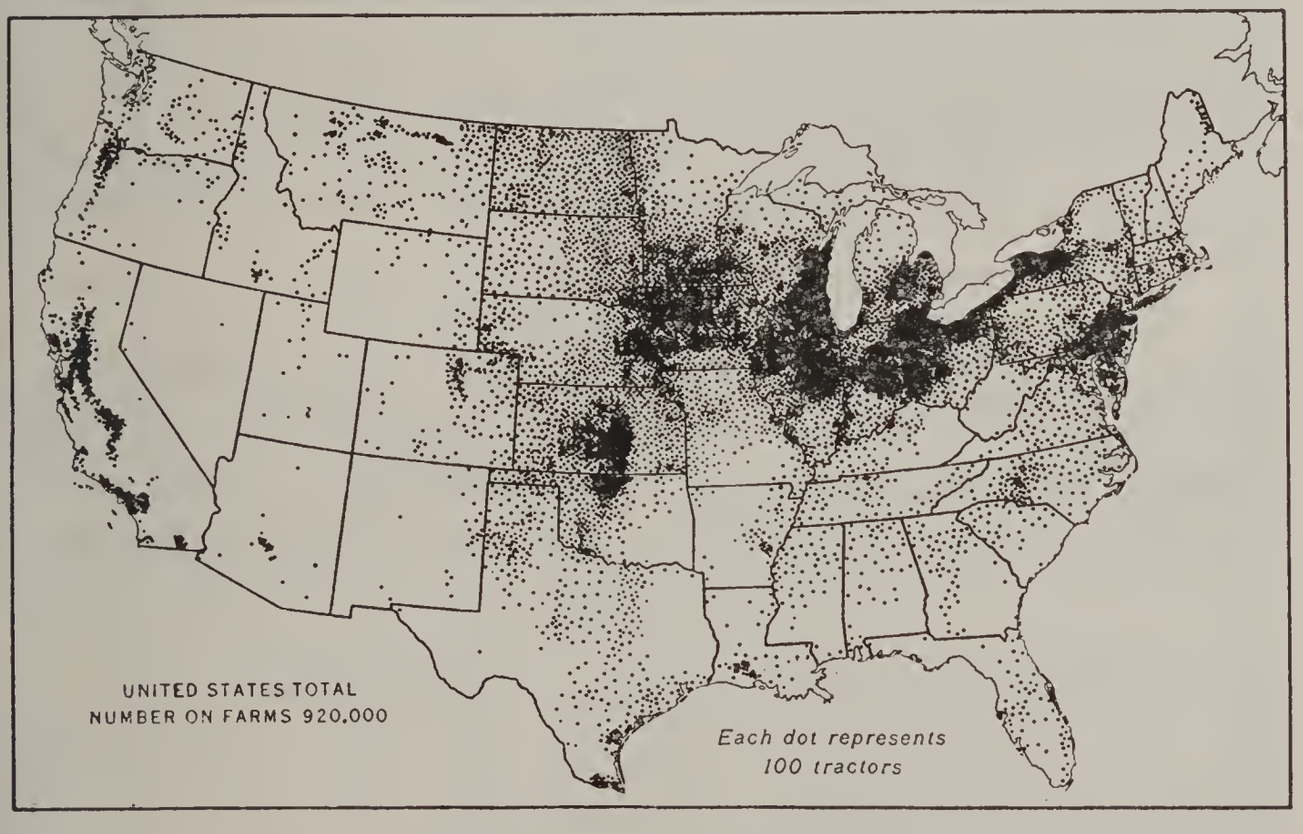

Figure 13.—Distribution of tractors on farms, April 1, 1930.

Source: Bureau of Agricultural Economics.

The field study of 1936 throws added light on the relative rate of tractor adoption (fig. 14). The farmers of the small-grain area were the first to adopt the tractor for general field work. Generally favorable topography, large fields, and a preponderance of crops not requiring intertillage were favoring conditions with the type of tractor then available. In the corn area and the western dairy area, adoption proceeded at rather regular rates until about 1924 when about 25 percent of the farmers interviewed in each of these sections had tractors. Following this, the general-purpose type of tractor was

put on the market and adoption increased rapidly until it stood above 60 percent of the farmers interviewed in 1936.

In the eastern dairy area a larger proportion of small and rough farms on which tractors are questionable investments is found. The

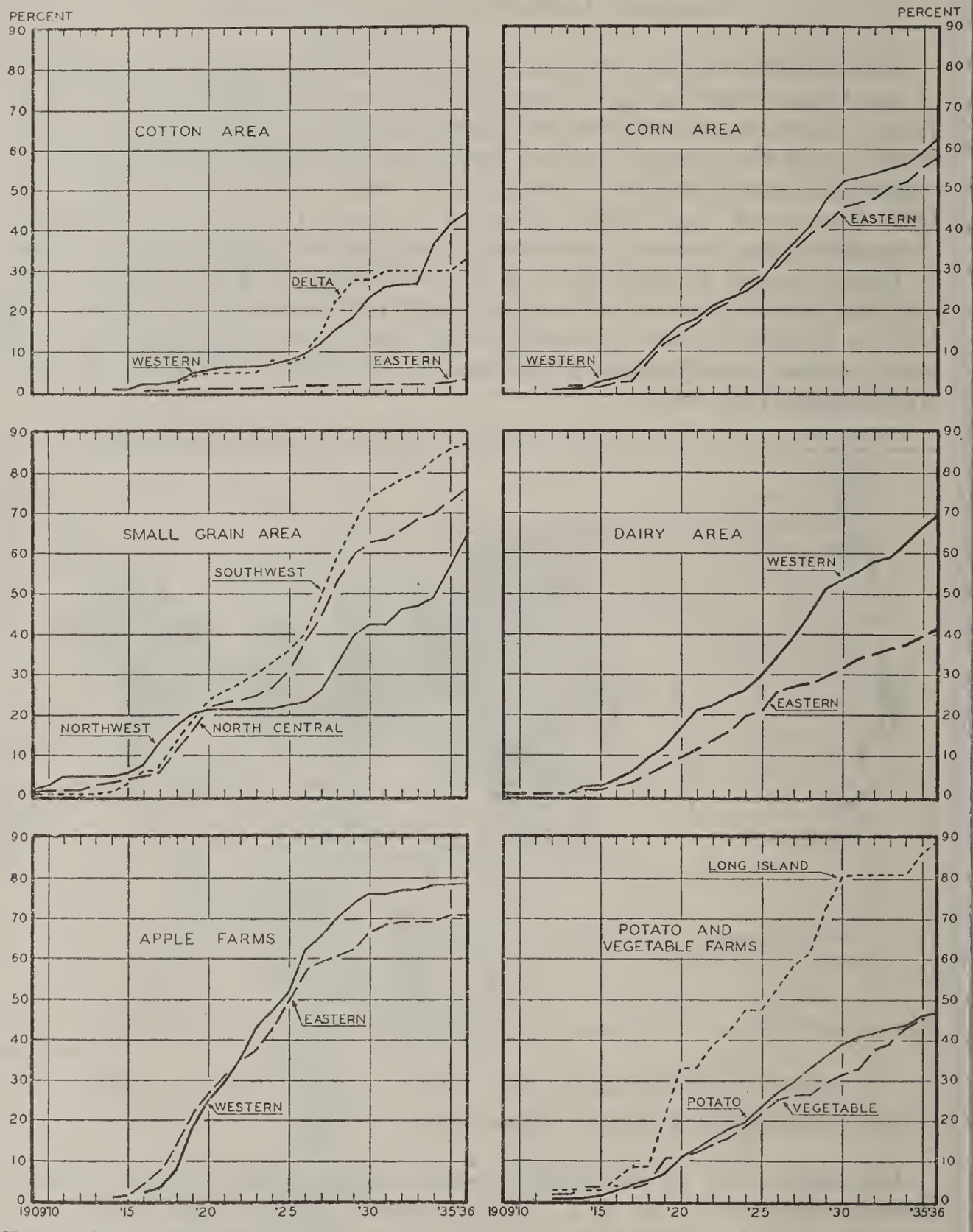

FIGURE 14.—Adoption of tractors, by major types of farms or farm areas, 1909–36.

Cumulative percentages of farmers interviewed in N. R. P. Survey of 1936 reporting use of tractors in the years indicated.

proportion of intertilled crops is also relatively lower than in the corn area. Therefore, we find tractors used by only about two-thirds as large a percentage of farmers interviewed here as in either the corn area or the western dairy area. In a sense, the inability of small

dairy farmers to use mechanical power economically puts them at a further disadvantage as compared to farmers on the larger, smoother farms.

In the apple area and in some of the vegetable areas studied, much work must be done with power in preparing the seedbed or cultivating for short periods, and there is little need for motive power the rest of the year. Under these conditions tractors have an advantage, since they require care and fuel only when they are being worked, while horses must be fed during the entire year.

On small farms in the cotton area, the tractor brings little benefit but considerable added expense. Consequently, few are used. On the large plantations of the delta section, and on the extensive cotton farms of the High Plains, however, the situation is quite different, and application has been rapid since 1925. Even in the Old South, the adoption of smaller sized tractors is now proceeding at a fairly rapid rate, principally on the larger and smoother farms.

It is thus apparent that the number of tractors has not reached anything that may be called a saturation point. Continued improvements in the tractors themselves, and in the implements they draw, are still increasing their usefulness. Further, it was found in the field study that tractors are used by a larger percentage of younger than of older farmers. As older men are replaced by younger ones who are more "machinery conscious," the percentage of farms with tractors may be expected to rise for some years.

Saving in Labor in Field Operation

Adoption of the tractor has meant a saving of farm labor in three important directions: (1) the capacity of the operator has increased because of the greater working width of implements generally used with tractors as compared with horse-drawn machines; (2) the tractor permits greater speed of operation than horses; (3) it has resulted in a saving of the farm labor formerly used in caring for horses and growing feed for them.

The greater speed of operation of tractors over the use of horses is a relatively recent development. Most of the tractors manufactured before 1924 or 1925 moved only a little faster than the horses they replaced. The modern farm tractor, however, moves a third or a half again as fast, and in some cases twice as fast. In some operations, such as plowing or cultivating, this may also bring a gain in the quality of the work. At the greater speed the soil is pulverized more thoroughly in plowing, and is thrown farther in cultivating so that more weeds are buried and smothered in the row.

Gain in effectiveness varies with different operations. Thus, the total saving in time can only be estimated and cannot be calculated accurately. On the conservative assumption of 1.3 million tractors operated on farms in 1938 for an average of thirty 10-hour days a year, and with an average increase in effective capacity per operator of 50 percent over horse-drawn units, the reduction in labor would amount to 150 man-hours per tractor, or a total of 195 million man-hours per year. As the older and slower moving tractors are displaced by newer models in the next few years, however, and as the average tractor is used for more hours per year, this saving may well rise until

it is a third again as great as the 195 million man-hours just mentioned, even aside from the change in number of tractors. The effects of the farm tractor extend further than the saving of labor in field operation.

FARM ADOPTION OF AUTOMOBILES AND TRUCKS

Application of Automobiles on the Farm

In 1909 there were about 300,000 automobiles and trucks in the United States, but it is not known how many of them were on farms. The number on farms rose during the next two decades to more than 2 million in 1920 and over 4 million in 1930. Low farm income after 1930 practically ended expansion in the number of farm automobiles for several years, so that the rise from 1930 to 1938 is estimated at not much more than 2 percent, or 80,000 to 90,000. The rate of adoption was similar for each type-of-farming area and resembles the typical growth curve in its early phases, but shows the effect of the depression of the early 1930's in more recent years. In general, the resulting distribution of automobiles on farms is similar to that of acreages of harvested crops, except that the concentration is greater in the North and is less in the South, where farm income is lower.

Because the farm automobile is used both for business and for personal uses, any attempt to estimate the effect of the automobile on farm employment is difficult.

Farm Adoption of Motor Trucks

Motor trucks began to be of appreciable importance on farms later than automobiles. In 1920, there were about 140,000 on farms, but purchases rose sharply during the 1920's, so that there were 900,000 by 1930, and probably about 1,000,000 in 1939. Adoption, however, did not occur uniformly in all areas. On the vegetable and apple farms surveyed, 80 to 90 percent of the farmers had trucks in 1936. At the other extreme, trucks were found on only 12 percent of the cotton-area farms and 18 percent of the corn-area farms.

In the corn area there was a pronounced decline in farm trucks after 1930; it is of particular interest that this was chiefly of trucks larger than 1 ton in capacity. The typical farmer in this area has relatively few loads of produce to market in a year and the development of commercial trucking has made it cheaper for him to call a local trucker to haul his produce rather than to go to the expense of maintaining a truck himself. This involves a reduction in labor by the farmer, but implies an increase in employment elsewhere.

Trailers and the Use of Tractors on the Highways

Many farmers who cannot afford trucks make shift with the aid of trailers. At present by far the greater number of farm trailers are pulled behind automobiles but with the application of pneumatic tires to tractors there is a trend toward the use of larger trailers drawn by rubber-tired tractors. This may lead to important developments, particularly for short hauls to shipping points or local markets. The speed of tractors in the late 1930's is too slow for very

long hauls and the combination of low speed with the cost of operating the tractor prevents use of such combinations with light loads. With certain modifications of the tractor it might be possible to use it rather extensively for this purpose.

Principal Effects of Farm Motor Vehicles

The use of automobiles and trucks by farmers has had profound influences on the agriculture of the United States, both with regard to processes of production and the life of the farm people.

It has been found that after purchasing a truck a fourth to a third of the farmers change their principal trading center and that usually the distance to the new market is about twice as great.[2] Greater ease in traveling and hauling makes a wider range of trading points available to the farmer and makes him much less dependent on his local dealers. This is undoubtedly advantageous to the farm people, but it has had serious effects on the small towns as well as on larger cities.

It cannot be said that motor vehicles have been entirely advantageous to all farm people. Most farmers still live on dirt roads. In muddy weather or in deep snow it is often more difficult to get from the farm to town or to a surfaced highway with an automobile than it would be with a team.

Despite such disadvantages, rural people have gained from the use of these vehicles—a trip which would have required all day 25 years ago can now be accomplished in an hour, and people now use far more transportation than they did in 1909. This brings economic advantages; but it also makes available greatly increased educational, medical, social, and recreational services. Much of this service was simply beyond the reach of farm people before the days of the automobile.

Throughout this chapter an effort is made to measure or evaluate the influences of the various types of mechanization on farm employment or labor requirements. In the case of the automobile, however, such measurement is particularly difficult, and the results are far from satisfactory. The automobile and truck are not simply substitutes for horses but provide additional services as well. The hours spent in traveling by automobile and in hauling farm produce by truck, therefore, cannot be compared with the hours previously spent in traveling or hauling with horses. Neither is the following comparison with the hours that would be required to perform present transportation services by means of horses altogether satisfactory, since much of the present service would not be performed if horses and railroads were the only means of transportation.

It may be estimated, conservatively, that the 5 million farm motor vehicles travel an average of about 4,000 miles per year each.[3] At a speed of 20 miles per hour, this would require 1 billion hours. If

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[2] H. R. Tolley and L. M. Church, *Motor Trucks on Corn Belt Farms* (U. S. Dept. Agr. Farmers Bul. No. 1314, 1923, p. 6); L. M. Church, *Farm Motor Truck Operation in the New England and Central Atlantic States* (U. S. Dept. Agr., Dept. Bul. No. 1254, 1924, pp. 10–11).

[3] Church, *op. cit.*, p. 16–17; W. L. Cavert, *Sources of Power on Minnesota Farms* (Minn. Agr. Expt. Sta., Bul. No. 262, 1930, pp. 54–62); W. M. Hurst and L. M. Church, *Power and Machinery in Agriculture* (U. S. Dept. Agr., Misc. Pub. No. 157, 1933, p. 10); F. D. Cornell, *Power on West Virginia Farms* (W. Va. Agr. Expt. Sta., Bul. No. 267, 1935, pp. 14, 17, 37).

the same number of miles of transportation were to be accomplished with horses at a speed of 4 miles per hour, 5 billion operator hours would be required, a difference of 4 billion hours. It should be remembered, however, that it is probable that no such amount of transportation would be utilized by farm people if they had to depend on horses for motive power. Another important influence of the automobile and truck is in the reduction in labor required to care for horses.

It has been estimated that each farm truck displaces between one and two work horses.[4] It is more difficult to estimate the effect of the automobile because farm people travel more after they get automobiles and because many of the trips were formerly made by horses that were also needed for field work.

It seems probable that about half the total displacement of farm horses between 1909 and 1936 was caused by the farm automobile and truck. Besides the reduction of labor in caring for farm horses, there was also a shifting of labor from raising horse feed to crop and livestock products which could be used for more direct human consumption. The reduction in labor on horses, however, does not measure net saving for the country as a whole. It is largely offset by an increase in labor in urban centers where automobiles are manufactured, or in oil fields where fuel is produced for their operation.

Adoption of the farm truck has been important in shifting to some extent the areas in which crops are produced. For instance, it has greatly increased the area from which milk or cream could be collected for a given collecting station as well as in maintaining quality better by more prompt delivery. In the Middle West, the truck, operated either by the farmer himself or by commercial truckers, has relieved the farmer of the work involved in driving or hauling the stock to the railroad station and loading them into a stock car. In addition, stock usually shrinks less in weight when hauled by truck than by train, for distances up to 100 miles.[5]

In shipping fruits and vegetables from farms to markets, the motor truck has become a principal means of transportation. For the country as a whole it is estimated that nearly 40 percent of the fruits and vegetables shipped to consuming markets during 1934 arrived in motor trucks. Further, the truck has been particularly important in the marketing of small grain.[6] It is estimated that hauling 100 bushels of grain to shipping points required 7.4 hours 25 years ago, compared to 3.0 hours in 1934–36. On this basis, the saving in farm labor by the use of the truck in hauling small grain alone has been about 45 million hours.

DISPLACEMENT OF FARM HORSES

Displacement of horses by automobiles, trucks, and tractors which began after 1915, did not become pronounced until 1919. In 1916 there were nearly 27 million horses on farms in the United States, of which just over 20 million were 3 years old or more; that is, were

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[4] H. R. Tolley, and L. M. Church, *Corn Belt Farmers, Experience With Motor Trucks* (U. S. Dept. Agr., Bul. No. 931, 1921, p. 31); Z. R. Pettet, *The Farm Horse* (U. S. Bureau of the Census, 1933, p. 40).

[5] G. N. Motts, *Motor Truck Marketing of Michigan Livestock* (Mich. Agr. Expt. Sta., Spec. Bul. No. 235, 1933), p. 28.

[6] See WPA N. R. P. Report No. A–10, *Changes in Technology and Labor Requirements in Crop Production: Wheat and Oats*, by Robert B. Elwood, and others, 1939, pp. 100–102.

of working age. By 1925, the total number of horses was down to 22.3 million and work horses to 19.9 million. Subsequently, tractor adoption was speeded up by the appearance of the general-purpose, or row-crop tractor. By 1938 the total number of horses and mules was down to 15.4 million and the number of work horses to 13.1 million.

It has been customary to use this absolute decrease in number of farm work horses as a measure of displacement by tractors, trucks, and automobiles. A more logical approach is through the change in ratio of work animals to acres of crops. The difference between actual numbers of work horses in the country in 1938 and the numbers that would have been required at the rate of one horse for each 16.5 acres of crop, as for the first 5 years of the period, was approximately 7.6 million head.[7]

From various data it seems likely that about half the displacement of horses that occurred up to 1935—or 2.8 million—should be attributed to the automobile and truck and the remainder to the tractor.[8] At this rate the displacement caused by the tractor through 1938 would amount to 4.8 million work horses, or slightly more than 3 horses per tractor, and to slightly under 0.6 horse per automobile or truck. Both of these figures seem conservative. With the displacement of 7.6 million head of work horses is associated, between 1909 and 1938, a decrease of at least 1.9 million head of colts under 3 years of age, needed to maintain the work-animal population.

Decrease in Labor Required To Care for Farm Power Units

It is estimated that there is a saving of about 50 hours a year in the labor needed to care for the farm power unit for each horse displaced by farm tractors. The tractor requires a certain amount of servicing and repairing but this is considerably less than in proportion to the labor on horses displaced. The tractor requires no labor when it is not in use, whereas the horse must be fed and cared for during the whole year. The same sort of saving occurs when horses are displaced in hauling or transportation by automobiles or trucks. The displacement of 7.6 million horses has resulted in a reduction in labor in caring for the combined farm power units of about 380 million man-hours. The relative saving in hours, however, is undoubtedly greater than the decline in number of workers. A large part of the labor on horses is spent during the winter season when there is a surplus of labor on most farms anyhow, while labor in care of tractors is mostly required during the crop-growing season when the tractors are being used from day to day.

Labor requirements on farms have been reduced because less time is spent on each remaining horse. With tractors performing much of the heavier work like plowing and disking, horses are fed less heavily than in earlier years, and have been supported to a larger degree on pasture. Man-labor per horse retained has declined about

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[7] See WPA N. R. P. Report No. A–9, *Changes in Farm Power and Equipment: Tractors, Trucks, and Automobiles*, pp. 62–63 for estimates of labor saved on farms by displacement of horses through 1935. The estimates given here are computed by the same method but brought up through 1938 on the basis of data from the Bureau of Agricultural Economics on recent numbers of horses.

[8] WPA N. R. P. Report No. A–9, pp. 62–65.

11 hours since 1909, a total of about 145 million man-hours on the 13.1 million horses retained in 1938. To this should be added also a saving of about 65 million man-hours formerly used in caring for about 1.9 million colts needed for replacements.

Shifting Feed From Horses to Other Livestock

The most far-reaching influence of farm mechanization has come through the shifting of land and labor from production of horse feed to production of feed for other livestock or for direct human consumption. It is estimated that the average work horse consumes annually the produce from about 3.5 acres of crops and 1.8 acres of pasture, while a colt under 3 years of age consumes about half as much. For the 7.6 million work horses and 1.9 million colts displaced this amounts to about 30 million crop acres plus 15 million acres of pasture. Since the remaining horses work less than before adoption of tractors and automobiles and are fed less heavily, this brings a reduction estimated at about one-tenth of the above, or another 3 million crop acres. This 33 million acres of cropland is enough, if planted in crops suitable for human consumption, to support about 16 million persons.[9] This shifting of land and feed undoubtedly had a strong influence in preventing the nation's food costs from rising as much as they would have done otherwise with the increasing population.

Labor released from production of horse feed is estimated at about 530 million man-hours, counting man-labor requirements at 28, 9, and 12 hours, respectively, for corn, oats, and hay. Part of this labor has been shifted from rural to urban areas, where it is now used to produce tractors and automobiles to replace the horses, and fuel to replace horse feed.

TOTAL REDUCTION OF LABOR FROM FARM AUTOMOTIVE EQUIPMENT

It is now possible to bring together the estimates of principal reductions in farm-labor requirements resulting from the adoption of farm automotive equipment, and also to make some rough estimates of the corresponding increases in labor that have occurred in urban areas.

Cause of reduction:	*Millions of hours saved*
Adoption of tractor for field operations	195
Reduction in labor in caring for farm power plant, through substitution of tractors and autos for 7.6 million horses	380
Reduction in care needed on remaining horses	145
Reduction in labor needed to grow colts for replacements	65
Total reduction in farm labor, exclusive of time saved in transportation	785
Labor shifted from production of horse feed	530
Grand total	1,315

[9] O. E. Baker estimates the per capita requirements at about 2 acres. See *Agricultural Land Requirements and Resources*: Supplementary Report of the Land Planning Committee to the National Resources Board, Part 3 (1935), p. 3.

The total labor saved on farms or shifted from the production of horse feed is equal, on the basis of these estimates, to a 3,000-hour work year for about 440,000 persons, although the actual reduction was probably much smaller, as much of the work on horses is required in slack seasons. Labor saved from the production of horse feed was mostly shifted in one way or another to other production on the farm, and has gone to support a part of the increase in population which occurred during the same period.

Shifting of Labor to Urban Areas

There was obviously no direct transfer of labor from the care of horses to manufacturing or servicing of automotive equipment. What is meant here by the shifting of labor is simply that as labor requirements declined on farms there were corresponding increases elsewhere to produce the equipment which replaced the horses. Indeed, not all the increase was in nonfarm areas. It has been estimated that production of cotton, mohair, and other farm products used in the needed replacements for farm motor vehicles in 1935 required some 20 to 25 million man-hours.

Labor represents the principal element of cost both of tractors and motor vehicles. It may be estimated, roughly, that 80 percent of such cost consists of wages for labor, and that the average wage rates in the industries concerned are not far from 60 cents an hour.[10] If we assume that the average life of a tractor is about 8 years, the 1.3 million farm tractors in 1938 would require an annual replacement of about 162,000. The average retail cost of these tractors was about $900.[11] The total labor used in producing the tractor replacements would thus amount to about 195 million man-hours. If 10 percent of this be deducted because of belt work which would otherwise have been done by some other type of mechanical power, we have a net figure of about 175 million hours. Following the same method of estimation we obtain the following figures for amounts of labor required to produce replacements, fuel, and repairs for farm tractors, trucks, and automobiles:

	Million hours
To manufacture replacements for tractors	175
Production of tractor fuel, repairs, etc	170
Total for 1.3 million tractors	345
To manufacture auto and truck replacements	580
Fuel and oil	280
Tires	130
Repairs	120
Total for 5 million autos and trucks	1,110

Has the adoption of farm automotive equipment meant a net reduction in labor for the country as a whole? For the tractor the answer seems clearly to be in the affirmative and the saving in field labor from

[10] *National Income in the United States, 1929–1935* (Bureau of Foreign and Domestic Commerce, 1936), pp. 27, 74, 99, 124; *Trend of Employment January 1935* (Bureau of Labor Statistics), and subsequent issues.

[11] The average value reported by manufacturers plus 20 percent for freight and dealer's margin. See *Manufacture and Sale of Farm Equipment and Related Products, 1935* (Bureau of the Census, 1936).

substitution of tractors for horses was estimated at 195 million man-hours. Of the 590 million hours reduction in care of horses and raising of colts for replacements about 370 million may be attributed to the adoption of the tractor. This makes a total saving of 565 million hours against an estimated 345 million hours required each year to produce tractor replacements, repairs, fuel, etc., aside from the shifting to other uses of about 335 million hours no longer needed to raise horse feed. The net saving on account of the tractor would thus appear to be 555 million man-hours.

Reduction of labor on farms caused by adoption of trucks and automobiles consists of 245 million hours no longer needed to care for horses and raise replacements, plus 195 million shifted from horse-feed production to other uses. Total saving on farms is thus about 440 million man-hours as compared to the estimated 1,110 million needed to produce replacements, fuel, tires, and so on, for the motor vehicles. This leaves a debit balance of 670 million hours or 130 hours for each motor vehicle to charge against the increased travel and transportation enjoyed by farm people and the shifting of labor from railroads to trucks.

Prospective Developments Regarding Farm Automotive Equipment

To what extent has the replacement of animal with mechanical power been completed on American farms? While prophecies are obviously very hazardous, there are a few trends which seem very likely to continue for at least a few years.

A much higher percentage of farms already have automobiles on them than either trucks or tractors. From this it may be inferred that future increases in farm automobiles are likely to affect farm employment less than are increases of the other two types of equipment. The tractor seems likely to cause the greatest further shift during the next few years. Further adaptations to the various farm power needs, tractor adoption on small farms particularly in the South, further application of pneumatic tires to tractors, and a consequent increase in tractor use on highways, all contain important potentialities for farm employment, as does the possibility of applying Diesel engines to farm tractors. All of these developments imply also some increase in needs for urban labor to produce the tractors.

CHANGES IN IMPLEMENTS

Use of larger power units has been accompanied by some pronounced changes in the implements drawn by them. Farm implements, however, serve many different specialized uses and their development from decade to decade is quite uneven. Four principal groups of implements, with regard to the function they perform are listed.

Main Groups of Farm Implements

The main groups of farm implements are:

(1) Tillage implements such as plows, disk harrows, spike-tooth, or spring-tooth harrows, rollers, cultipackers, and so on, which are used over the greater part of the country in preparing the seedbed or ex-

terminating weeds before the crop is planted. Also in this general group are other machines such as the vertical disk plow and duck-foot field cultivator, which are more localized in their use. Most of the tillage implements may be applied in preparation for any one of several crops and are often substituted for one another, as a disk for a spiketooth harrow when the soil is very hard or full of clods, or the roller for the harrow under some conditions. For the most part there has been only a little change in the general principles of this group of machines during the period under consideration.

(2) Planting and seeding equipment like corn and cotton planters, grain drills and seeders, potato planters, transplanters, and so on. In general, these are more specialized than the tillage implements, but still some planters may be used on two or more crops, as the corn planter to plant cotton after certain modification. The grain drill may be used for various small grains, or with part of the seeding devices blocked, may be used to drill corn or soybeans. Principal types of planters and seeders have also been changed only a very little since 1909.

(3) Cultivating equipment, of which the most common is the shovel cultivator used on corn, cotton, potatoes, and similar crops. Various sized shovels, teeth, or sweeps may be attached to the same cultivator frame to conform to soil condition, stage of growth of the plants, or type of weed growth that is to be controlled. There are also disk cultivators, rotary hoes, and spring-tooth weeders for use under more limited conditions. As with the tillage implements basic designs have changed little since 1909.

(4) Various harvesting machines, such as mowing machines, grain binders, combines, corn binders, corn picker-huskers, potato diggers, cotton strippers, sugar-beet lifters, and various others. Harvesting operations usually require relatively large amounts of labor if performed by hand or by primitive methods. They vary greatly in the degree to which it is feasible to reduce the operations to a simple routine that will permit mechanization. The harvesting of grains is a relatively simple process and removal of the crop from the land can be carried out in a routine manner. Consequently grain harvesting was one of the earlier processes to be mechanized. If the straw is removed with the grain, the two can easily be separated later on. At least so it seems now, though this probably seemed a formidable task when performed by more primitive methods.

With corn it is more difficult to simplify the operations so that mechanical methods can be applied. Ears grow at varying heights on the stalk and are heavy enough so that a certain proportion are likely to be knocked off before they are engaged by a mechanical picker. Where it is desired to save the stalks also, the large amount of heavy and partly green fodder brings additional difficulties.

With potatoes the problem of digging is relatively simple, but no generally accepted mechanical method has been developed for picking up, since stones and clods are often of the same size and shape. With vegetable crops the difficulty of mechanical harvesting is even greater because vegetables are easily injured by mechanical handling. Also, with some crops it is necessary to go over the field several times, discriminating between the ripe and the green vegetables. With fruits there are all the difficulties found with vegetables and the added one of picking from trees. Thus, it is on fruits and vegetables

that mechanical harvesting has lagged most. The operations of planting and cultivating are already mechanized, for the most part, and a man can raise a much larger crop than he can harvest, so it is on these crops that the greatest relative amount of employment of a seasonal character is found.

Principal Changes in Farm Implements

The principal trends or changes in farm implements since 1909, may be grouped under four headings: (1) Increase in capacity from greater size or greater speed, (2) wider adoption of machines previously available, (3) development of new implements, and (4) improvement in efficiency of implements. These will be taken up in the order listed.

Increase in Size or Capacity of Machines

Increase in size or capacity has probably been the most important change. For instance, there has been a pronounced trend toward larger plows in practically all areas affecting agricultural employment, although the one-bottom plow is still the most common in the South and in New England. Thus in the 1936 N. R. P. survey there was a decline in the one-bottom plows reported in the eastern dairy area from 99 percent in 1909 to 70 percent in 1936. In the eastern and delta cotton areas 99 percent of the plows were still reported as of one bottom in 1936, and 39 percent were drawn by one horse. In other areas the shift was more rapid; thus one-bottom plows in the corn area declined from 53 percent of those reported in 1909 to 24 percent in 1936.

Plowing is one of the most time-consuming operations on a majority of farms. Consequently the shift to more power and larger plows has resulted in a relatively large saving of labor. Thus, in the cotton areas it was found that nearly 9 hours were required to plow an acre of land with a one-horse, one-bottom plow, while a three-horse, one-bottom plow took 3.5 to 4.3 hours. Changing to a five-horse, two-bottom plow reduced the time to 2 hours, and a two-bottom, tractor plow required only 1.0 to 1.6 hours per acre. Although the change to tractor equipment brought a relatively large labor saving, it should not be forgotten that a decline in hours per acre plowed has also occurred on farms operated entirely by horses.

Because of its heavy draft, the disk harrow was one of the first implements to which tractor power was applied. Application of the tractor permitted the use either of larger single disks or a change to tandem machines that perform about the same amount of work, once-over, in preparing the seedbed that single disks do when the land is gone over twice.

Adoption of larger and more effective cultivating equipment has been one of the more important means of saving labor in crop production in nearly all areas except the eastern cotton area, where there has been but little change. In this area 72 percent of the cultivators reported for 1909, and 60 percent in 1936 were one-horse implements that made two or even three trips in cultivating each row of corn or cotton. In 1936, one-row, two-horse cultivators had increased from 21 to 31 percent of those reported. Even this type does not represent a very efficient machine in the use of labor, but it does represent a doubling of performance over the one-horse type.

In the corn and western dairy areas, in 1909, 82 percent and 98 percent of the cultivators, respectively, were of the one-row, two-horse type, while in 1936 the corresponding percentages were 47 and 78. In 1936, 25 percent of the cultivators reported in the corn area were two-row, horse-drawn machines and 19 percent were tractor cultivators, two rows or larger in size. Again it is noteworthy that there was an increase in size of horse-drawn cultivators as well as adoption of cultivators drawn by tractors.

Cultivation required, in 1936, from one-fourth to one-third of the labor used in producing cotton prior to harvest in all sections except the western semiarid. With corn, it accounted for about one-third except in the small-grain areas where it took one-half of the preharvest labor. Savings in labor requirements on these crops have been closely related to the changes in cultivating equipment. Thus, if a farmer changes from a two-horse, one-row cultivator to a two-row tractor implement, he is able to increase the area cultivated in an 8-hour field day from approximately 5.5 to 18 acres.

In harvesting operations the size of implements used has shown rather diverse trends. With small grains, the general trend has been toward larger binders, where binders are still used, and some reduction in the percentage of 5- and 6-foot machines is reported. With combines, however, the recent trend has been toward the adoption of smaller machines by farmers in areas not previously using combines. The older combines were large, heavy machines and were used almost entirely in the Northwest, in California, and in parts of the small-grain area. Smaller and lighter machines have made it possible to apply combines on smaller acreages of wheat or of other crops.

Introduction of Machines Into New Areas

The combined harvester-thresher has been the outstanding case of the introduction of an existing machine into new areas, but it is by no means a new machine. A machine of this type was used in Michigan in 1837 and in California in 1854. It was well established in California in the 1880's. Introduction in the small-grain area began during the World War, stimulated by high wheat prices and a shortage of farm labor. After 1920, wider adoption of the combine occurred in conjunction with adoption of the tractor in the small grain area. Recently the development of smaller and lighter combines, with cutting widths down to 3.5 feet, has led to adoption of these machines in many parts of the corn area and, to a small extent, in eastern areas also. The machine has been applied to the harvesting of other small grains as well as wheat, and to soybeans, which lend themselves particularly well to combine harvesting.

Adoption of the combine is almost invariably accompanied by a decline in farm employment. The most spectacular reduction occurred in the small-grain area, where a great army of migratory harvest hands disappeared almost entirely within a decade. If we count a saving of 3 hours per acre on 400 acres per combine, the total saving for the 70,000 machines estimated to be in use in 1936 would amount to about 84 million man-hours. Since that year, sales of combines increased sharply from 14,000 in 1936 to 28,000 in 1937 and 42,000 in 1938. The machines sold in the latter year, however, included over 26,000 that were of 6-foot cutting width or smaller.

As new implements are developed, some older ones may decline or go out of use. An example of this is the header, which was widely used between 1910 and 1920 in some sections of the small-grain area. For 1919, headers were reported for 54 percent of the farms studied in the 1936 survey in the southern small-grain area and 29 percent in the northern small-grain area. The combine displaced a majority of the headers so that they were reported by only 19 percent of the farmers interviewed in these two sections in 1929.

Development and Adoption of New Implements

Although farm mechanization has made great strides since 1909, most of this has been concerned with adoption or modification of previously existing machines. Relatively few new ones have come to be of great practical importance. There have, however, been a few new machines developed, and among these may be mentioned the vertical or one-way disk plow, the duckfoot field cultivator, the pick-up hay baler, and the field ensilage cutter.

The vertical disk plow is used in place of an ordinary moldboard plow or disk plow in some parts of the small grain area. It requires less power per foot of working width than a moldboard or ordinary disk plow, and when properly used leaves the surface rough and crop residue only partly buried. Consequently its use tends to increase the absorption of water and to reduce wind erosion.

The duckfoot field cultivator is used chiefly to prepare the seedbed and in cultivating fallow land in the northern small grain area. By 1936 it was used by about a quarter of the farmers interviewed in this section, and by 8 percent of those in the southern small grain area. The 11- or 12-foot tractor-drawn duckfoot covers an acre in about 15 minutes. Where used, it tends to displace the disk harrow and other secondary tillage implements.

The pick-up hay baler and the field ensilage cutter have as yet been adopted by relatively few farmers. They may be of greater importance later on. The former materially reduces the labor of hay harvest and the latter takes most of the heavy manual labor out of silo filling.

As regards its effect on farm employment up to the present, a more important machine is the corn picker-husker. This machine was available as a one-row, horse-drawn machine shortly before 1909, but its adoption was very small until during the war, when high prices and a shortage of labor encouraged adoption for a short period. It was not until the late 1920's, however, that the corn picker began to be of widespread use. At that time there became available a tractor-drawn, two-row model operated by means of a power take-off. This machine had more than twice the hourly capacity of the old, one-row, horse-drawn machine. Adoption has been confined largely to the corn area. Total sales amounted to 4,600 in 1936, about 14,000 each in 1937 and 1938, and 10,800 in 1939. This machine saves 2 or 3 hours of labor per acre of corn as compared to hand picking. The effect of its adoption on farm employment has been pronounced. It has displaced a large number of workers, chiefly from small towns, who previously found from 6 weeks' to 2 months' work in the fall picking corn.

Improvement in Efficiency of Farm Machines

Improvement in design has in one sense been a prerequisite to the wider adoption of such machines as the mechanical corn picker, the combine, and others. Not only has a change in the functional design

of some machines taken place since 1909, but a more subtle and widespread general improvement in most of the other implements has been noted as well. A general trend toward greater convenience in operation, a use of better materials in many cases, the adoption of antifriction bearings in moving parts, and of enclosed bearings to keep out dirt and prolong the life of the machine are a few of the improvements made. Attention to the comfort of the operator has also been of importance, and has, incidentally caused a pronounced increase in the cost of some implements. In order to provide a seat for the operator of such an implement as a plow or a cultivator it is necessary to add a frame and wheels to what might otherwise be a simpler and less expensive machine. It would be impossible to appraise exactly the influence of improved design on the mechanization of farm operations, but this influence has been pronounced. Also in leading to more smoothly operating machines the same improvements have led to an appreciable direct saving of labor in the actual operations of crop production.

PROGRESS OF MECHANIZATION

How far has the process of mechanization advanced toward its completion? The limits to mechanization change with each new improvement. Consequently any generalizations of this type can only refer to the degree of adoption of the appliances available at the present time. Table 32, based on data from N. R. P. Report A–11, "Changes in Farm Field Implements," illustrates the typical changes in labor requirements on wheat, corn, and cotton in areas where these are the major crops. It also shows the variation in labor requirements in 1936 as between the more effective outfits and the least effective ones still used.[12] The more effective machines referred to are not, in most cases, the largest ones available, but are machines which are rapidly being accepted. They are ordinarily machines which could be used on at least half the acreage of the crops named, in the areas where these are major enterprises.

Interesting comparisons can be made of the relative status of mechanization of these three crops. In the small-grain area the equipment combination which was most common in 1909 is now perhaps the least effective still in use; while the equipment most frequently reported for 1936 is not far behind the most effective available. That is to say the mechanization process here is far advanced.

In the corn area mechanization has progressed more slowly. Performance of the typical operations required about three-fourths as much labor with the most common equipment in 1936 as in 1909. The most common equipment in 1936 required much more time than the most effective machines available. The latter were able to perform the same work in about 6 hours an acre as compared to 12 for the most common sizes and types. There was still in use, however, equipment which required 18 hours to perform the same operations. This is 2 hours more than was used with the typical equipment of 1909.

In the cotton area mechanization has made very little progress. The most common combinations of equipment in 1936 were the same as in 1909. Furthermore, except for the plow, these were the smallest

[12] For most machines the "most effective" or "least effective" refers to machines used by as many as 5 percent of the farmers interviewed in the 1936 field study.

and least effective available in 1936. There are larger implements which can perform the machine operations in about one-sixth as much time, that is, in about 4 hours as compared to 24. The important operations of chopping and picking, however, have not been affected by mechanization and these required approximately 70 hours an acre in 1936 with little discernible change from 1909. Any change in the bulk of the labor on this crop thus depends upon the development of more satisfactory mechanical methods of weed control, thinning, and harvesting.

In conclusion: Opportunities for further reduction in agricultural labor requirements appear to be greater in the cotton and corn areas than in the small-grain area. While it is probable that labor requirements in the production of small grain will continue to decline, the major effects of mechanization here are already accomplished. In the corn area mechanization is well advanced but is continuing and may be expected to reduce the needs for labor for the next several years. In most parts of the cotton area the process is only beginning. Barriers in the form of operations which have so far not been mechanized with any degree of satisfaction are difficult to overcome.

Present evidence indicates that in all areas shifts to types and sizes of machines like those indicated in the last column of table 32 will be more important than changes to extremely large machines. The largest possible machine is unlikely to be the most economical under conditions of the average farm. Large machines are difficult to operate in the smaller fields, the investment per acre of crop is likely to be larger, and there is more loss from operating interruptions as working width becomes greater.

TABLE 32.—*Effect of typical power and machinery combinations on the labor required to grow an acre of small grain, corn, and cotton* [1]

Labor	1909	1936		
	Most common equipment [2]	Most common equipment [2]	Small equipment [3]	High capacity equipment
	Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
WHEAT, IN SMALL GRAIN AREA				
Preharvest labor	4.7	1.4	4.7	0.8
Harvest labor	4.0	.7	4.0	.6
Total	8.7	2.1	8.7	1.4
CORN, IN CORN AREA				
Preharvest labor	10.6	6.8	12.5	3.7
Harvest labor	[4] 5.6	[4] 5.6	[4] 5.6	2.6
Total	16.2	12.4	18.1	6.3
COTTON, IN EASTERN AND DELTA COTTON AREAS				
Preharvest, work with machines	24.5	24.5	29.4	11.0
Hoeing and chopping [4]	25.0	25.0	25.0	25.0
Picking and hauling [4]	50.0	50.0	50.0	50.0
Total	99.5	99.5	104.4	86.0

[1] WPA N. R. P. Report No. A-11, *Changes in Power and Equipment: Field Implements*, by E. G. McKibben, J. A. Hopkins, and R. A. Griffin, 1939, pp. 95–97.
[2] Equipment most frequently reported by farmers interviewed in 1936 N. R. P. Survey.
[3] Less effective machines, reported by at least 5 percent of farmers interviewed.
[4] Work done by hand.

CHAPTER VI. DEVELOPMENTS IN METHODS OF CROP AND LIVESTOCK PRODUCTION AFFECTING AGRICULTURAL EMPLOYMENT

Increasing use of larger power units and larger or more efficient machines has resulted chiefly in the performance of the same operations in crop production with a smaller amount of labor per acre. In contrast to changes of this type are changes in method which yield a greater output per acre or per head of livestock but without appreciably changing the labor requirements. This may be as important in its ultimate effect on farm employment as the more direct saving in labor.

As a population of given size requires about a certain quantity of food and textile materials, an increase in yield means that a smaller number of acres or of animals is required, and consequently a smaller amount of employment. Thus, if the yield increases more rapidly than the population, other things being equal, it becomes necessary to reduce acreage, export a greater proportion of the crop, or else force it into domestic consumption by means of lower prices. The latter step, when applied to farm produce, involves sharp reductions in values. And these ultimately, though slowly and painfully, force a shift to other employment.

The most important changes in methods of crop production that have effected greater yields since 1915 without greatly changing the amount of labor required may be grouped under four headings:

(1) Improved methods of soil management, including methods of controlling erosion, and maintaining soil productivity by the use of green-manure crops, improved rotations, or commercial fertilizer.

(2) The improvement of crop varieties to achieve greater yields or resistance to diseases and shipping losses.

(3) Improvement in cultural operations, as in methods of planting, placement of fertilizer, or sequences of various operations.

(4) Improved methods of combating plant diseases and insect pests, which often cause heavy losses.

DEVELOPMENTS IN SOIL MANAGEMENT

Important discoveries and developments have been marked in the sphere of soil management, but their adoption by farmers has lagged. In the Southeast, improper construction of terraces on some farms, neglect on others, and the tillage of land which should not have been put into crops have resulted in serious erosion of thousands of acres.

The great emphasis placed by the Soil Conservation Service and the Agricultural Adjustment Administration on soil conservation, and particularly on erosion control, since 1933 has made many farmers increasingly aware of the problem. An important means of pre-

venting erosion is to keep erosive land out of crops and put it in pasture or forage crops. This means changing rotations and implies a reduction in labor requirements. Unless the forage consists of high-yielding crops, such as alfalfa, the value of the total crop production of the farm is likely to be reduced immediately after the shift, though this may avoid ultimately an even greater loss of productivity. The production of livestock is involved in shifts of this type because of the changes in proportions between forage and grain crops. If more forage is produced, it is necessary to keep more cattle and sheep and fewer hogs. More dairy production and less fattening of beef is generally implied. Also, adding more forage per pound of grain to rations where these elements are already in balance may be expected to yield less product per pound of total ration.

More positive means of preventing erosion are contour farming, strip farming, and the construction of terraces which imply an increase in labor. Contour farming means the planting of tilled crops along the contours of the land instead of running the rows parallel with the fences without regard to the direction of slope. Strip farming involves planting alternate strips of different crops along the contour, usually alternating intertilled crops, such as corn, with crops which are planted solid, such as small grains or hay crops. Terracing also implies cultivation along the slopes.

Each of these methods has the great advantage of protecting the land. Each has some costs or disadvantages. A slightly greater amount of labor is required to plant and care for the crops unless the strips along the contour are quite long. Just how much difference this makes is not yet known precisely; probably it amounts to somewhere between 5 percent and 10 percent. Besides this, where control of weeds is a serious problem, more labor may be required in preventing weed growth. Thus it is not possible to cross-check and cross-cultivate corn if planted on the contour and lower yields may result unless additional labor is applied.

Crop Rotations and Cropping Systems

One of the most widely advocated means of maintaining or increasing land productivity is the adoption of a regular crop rotation with a legume as one element. Rotations help materially in maintaining fertility and crop yields. Further, they often facilitate control of weeds, plant diseases, and insect pests, and may save considerable labor in preparing the seedbed for succeeding crops. Thus, in the Middle West oats are usually planted directly after corn without plowing. Since the corn-stubble land is already in fair tilth, it is necessary only to disk it before planting.

Rotations of many years' standing are found in many sections of the northeastern States. In the Middle West the great supply of rich, new land made it profitable to follow exploitive methods for some decades before changing to a soil-conserving policy. At present, under the continuous encouragement of the State extension services, Soil Conservation Service, and other agencies, more and more thought is being turned to crop rotation, and apparently the number of farmers adopting desirable rotations is steadily increasing. The net effect on farm-labor requirements in the near future is likely to be small, but the ultimate effect on maintenance of productivity will probably be important.

Use of Green-Manure Crops

Soil specialists advise the inclusion of a green-manure crop in the rotation if at all possible. Decaying vegetable matter increases the solvent power of the soil water and consequently makes more available to the growing crop both the plant nutrients already in the soil and those supplied in fertilizer.[1] In addition to this, if the green-manure crop is a legume, it is able to draw a considerable part of the nitrogen it needs from the atmosphere, thus providing a cheap source of this plant-food element.

In the South the most common leguminous green-manure crops are vetch, cowpeas, soybeans, crimson clover, bur clover, sweet clover, and velvet beans. In the Corn Belt sweet clover is the most common, although other crops are also used. Great impetus has been given to the use of green-manure crops by the Agricultural Adjustment Administration, which has encouraged their production on acreages kept out of crops by its contracts. Benefits have been paid for the purchase of seed and lime. It is highly probable that, after this start, at least part of the increase in use of green manures will become permanent even without the subventions.

Use of Fertilizers

The eastern cotton area for many years has been the heaviest user of commercial fertilizer. Fertilizer has also been used in considerable amounts in the northeastern States and elsewhere on such intensive crops as sugar beets, potatoes and vegetables. Its use has gradually been spreading in the Middle West (fig. 15).

In 1936, 95 percent of the land in cotton in the States of Alabama, Georgia, North Carolina, and South Carolina was fertilized, as compared with 37 percent in Arkansas, Louisiana, Mississippi, and Tennessee, and only 3 percent in Oklahoma and Texas. In the eastern cotton States about 50 percent more fertilizer was used per acre than in the central and western States.

In the eastern dairy area commercial fertilizers have been widely used for many years. Fertilizers containing phosphorus have been applied more or less regularly to the wheat crop in this area as well as to more intensive crops. In the corn area such fertilizers have been used in important amounts only in Ohio and Indiana. However, quantities used in the region have increased continuously except during the depression.[2]

An important new discovery is that the effect of commercial fertilizer is affected strongly by its placement. If applied too close to the seed, germination may be delayed or prevented. Some noteworthy increases in yield have been obtained by placing the fertilizer in a band a few inches away from and slightly below the seed. Farm practices to this end are incompletely developed, but the change promises in-

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[1] Wm. C. Holley and L. E. Arnold, *Changes in Technology and Labor Requirements in Crop Production: Cotton* (WPA N. R. P. Report No. A–7, September 1938), pp. 78–81.

[2] L. K. Macy and Others, *Changes in Technology and Labor Requirements on Crop Production: Corn* (WPA N. R. P. Report No. A5, June 1938) p. 29.
R. B. Elwood and others, same source: *Wheat and Oats* (WPA N. R. P. Report No. A–10, April 1939), pp. 76–77.

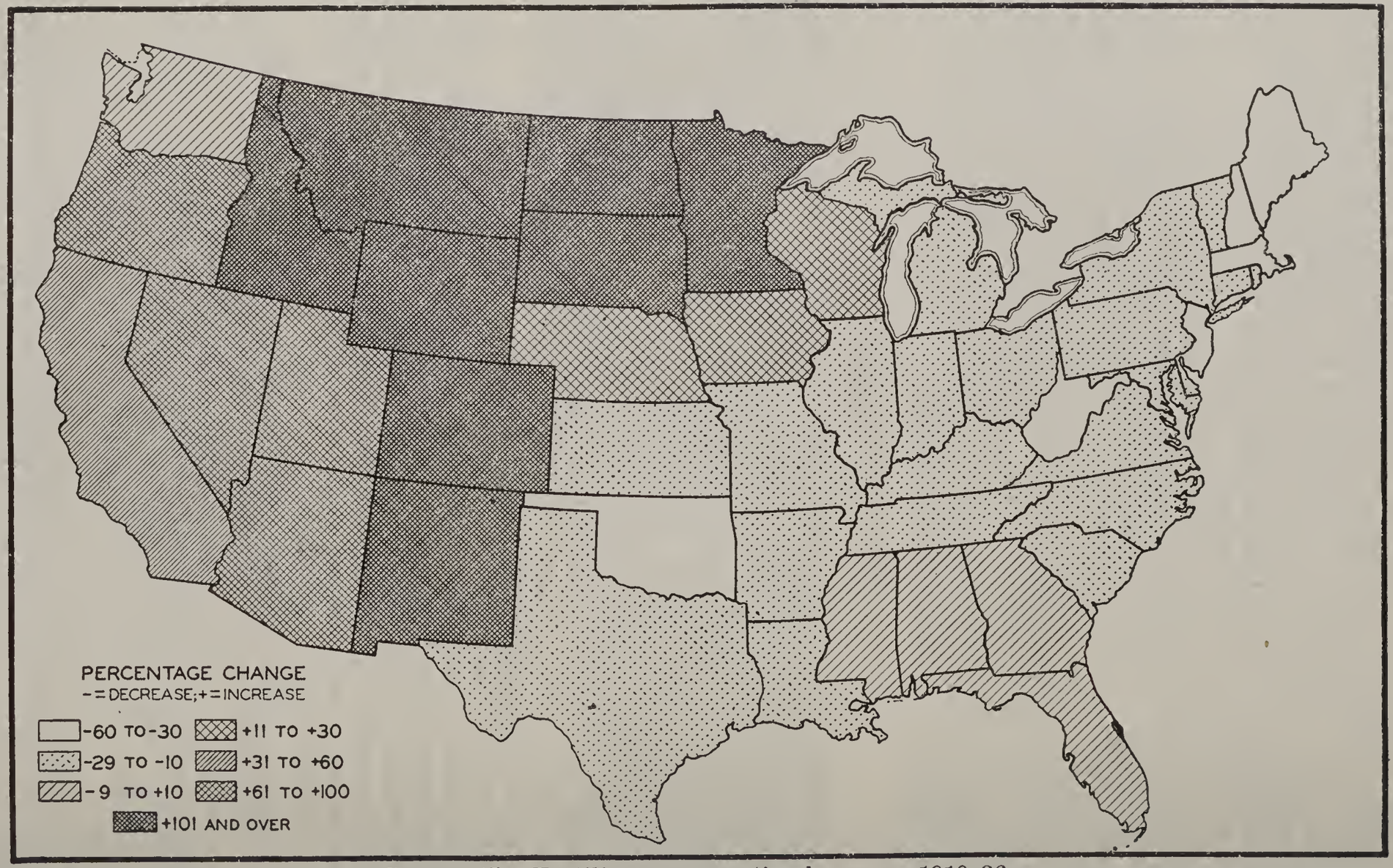

FIGURE 15.—Fertilizer consumption by areas, 1910–36.

Source: Herbert Willett, *Fertilizer Consumption in the United States* (National Fertilizer Association, Washington, D. C.).

creases in production with little or no additional labor.[3] Another important development is supplying small amounts of minor plant-food elements, like manganese or copper, to soils deficient in them.

BREEDING AND IMPROVEMENT OF CROP VARIETIES

Improvement in varieties of crops by breeding and selection has been one of the most fascinating chapters of recent agricultural history. With the increasing knowledge of genetic principles and their application, agronomists and horticulturists of the United States Department of Agriculture and of the State experiment stations have brought about some remarkable improvements in yielding ability and in other desirable crop characteristics.

Another purpose of plant breeding and selection is to improve quality. The lengthening of fiber of cotton is one illustration. Improvement of the flavor, palatability, and keeping qualities of fruits and vegetables are other examples. Plant breeding has also been a major weapon against diseases and pests. Varieties of certain crops have been developed to permit their production under different climatic conditions.

Breeding and Improvement of Corn[4]

Economically, one of the outstanding results of corn breeding has been the acclimation of varieties of corn to the semiarid regions of the small-grain area. Figure 16 shows the great expansion that has taken place in corn acreage in the Northern States and in the Great Plains. This was possible because varieties of corn were developed that could be raised in the short growing season of the northern States and under the semiarid conditions of the western part of the small-grain area.

Until recently the principal effort in corn breeding was to increase the yield of open-pollinated varieties. Since corn is cross-pollinated and since the pollen is carried for considerable distances, varieties cannot long remain pure. Also, different farmers have different ideals in selecting their seed corn. Consequently, there are wide differences between strains of the same variety.

The various available methods of selecting open-pollinated corn have shown limited results in increasing yields. Considerable improvement, however, has been obtained through the corn-yield test and type demonstrations. It was estimated that approximately 10 percent of the corn acreage of Iowa in 1928 was planted to high-yielding strains located through seed tests, and that the results showed an increase of about 1½ bushels per acre.[5]

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[3] Wm. C. Holley and L. E. Arnold, *op. cit.*, p. 86; H. E. Knowlton and Others, *Changes in Technology and Labor Requirements in Crop Production, Potatoes* (WPA N. R. P. Report No. A–4, March 1938), p. 49.

[4] The greater part of this section is a condensation of the more complete discussion of the same subject by Lloyd E. Arnold, in WPA N. R. P. Report No. A–5, *Changes in Technology and Labor Requirements in Crop Production: Corn*, pp. 11–29.

[5] H. D. Hughes and Others, *High Yielding Strains and Varieties of Corn for Iowa*, Iowa Agr. Expt. Sta. Bul. 265, 1929, pp. 63–76.

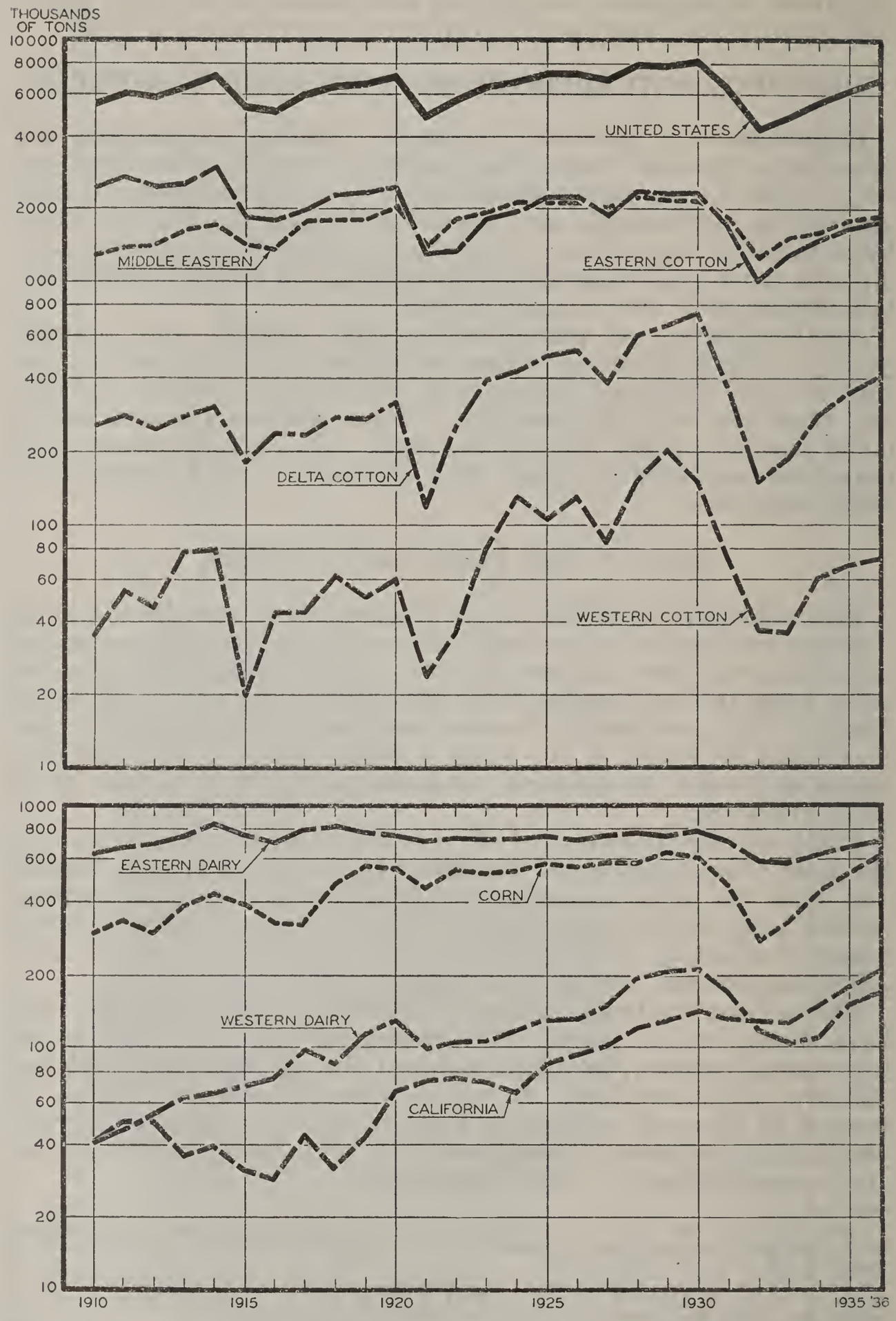

FIGURE 16.—Percentage increase and decrease of corn acreage, by States, 1009–29.

Source: Derived from data in *Revised Estimates of Corn Acreage, Yield and Production, 1866–1929*, U. S. Department of Agriculture, Bureau of Agricultural Economics (processed, May 1934).

Development of Hybrid Corn

Hybrid seed corn is mostly a development since 1930, although much preparatory work was done earlier by the workers of the United States Department of Agriculture and the agricultural experiment stations. The production of hybrid seed involves the production of two pure parent strains, in which desired characteristics have been fixed by inbreeding. These strains are then crossed to produce the hybrid seed. The resulting corn possesses a hybrid vigor which usually means higher yields, and may possess other desirable characteristics, such as drought or disease resistance. But the hybrid vigor lasts for one generation only and the grower must get hybrid seed each year. Considerable additional labor is required to produce hybrid seed. It has been estimated that enough hybrid seed to plant 50 percent of the corn acreage of the corn area would require about 2½ million additional man-hours of labor.[6]

Justification of this additional labor is found in the increase in yield obtained. Because of this advantage, acreage planted to hybrid seed in the corn area has shot upward at an astonishing rate until hybrid seed was used on 69 percent of the acreage planted in the corn area in 1939, according to the Agricultural Marketing Service. It has been estimated that by 1945 the effect of hybrid seed corn may amount to a 20 percent increased yield in the Corn Belt, or 6 percent to 8 percent of the national production.[7] In areas where corn is a minor crop there is less to be gained from the hybrid seed. Consequently, hybrids are likely to spread into other areas at a slower rate.

Improvement of Wheat[8]

New varieties of wheat have been developed or introduced in three different ways: Introduction from other countries, selection, and hybridization. Ninety-one varieties of all classes of wheat were distributed between 1909 and 1934. These occupied, in the latter year, 52 percent of the wheat acreage of the country and had an average potential increase in yield[9] of 9.2 percent, or about 40 million bushels for the acreage on which they were grown. Of this amount, approximately 25 million bushels may be attributed to new varieties of hard red spring wheat, and 4 million each to new varieties of hard red winter and soft red winter. One important objective in improvement of wheat varieties has been to develop resistance to certain diseases such as stem rust, leaf rust, and bunt. New varieties, such as Thatcher, have been important in reducing disease loss.

It cannot be said that the benefit has been shown by any pronounced increase in average yield for the country as a whole. Average yield for the United States since 1930 (omitting years of drought) has been about the same as that 25 or 30 years earlier. But maintaining the yield at this level represents something of an achievement. In western areas the development of methods of dry farming have pushed

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[6] Lloyd E. Arnold, *op. cit.*

[7] Report of the Secretary of Agriculture, 1938, p. 88.

[8] This section is a condensation of the more complete discussion of the same subject by Lloyd E. Arnold in WPA N. R. P. Report No. A–10, pp. 68–72.

[9] The potential increase in yield means the yielding ability of the new varieties over a standard variety adapted to the soil, climate, and elevation for which the new varieties were intended. That is, different new varieties may be compared with different standard varieties.

wheat onto poorer and drier lands where yields are lower. The yielding ability of land has undoubtedly suffered some loss where there has been serious erosion or soil depletion. It is safe to say that yields in recent years, in all probability, would have been lower than they were in 1909 had it not been for the introduction of these improved varieties.

Improvement of Oat Varieties [10]

Fifty-seven improved varieties of oats have been distributed in the United States since 1909.[11] In addition, 125 superior strains have been selected or hybridized, many of them with such desirable characteristics as resistance to cold, to lodging, and to diseases. In 1936, it was estimated that the varieties distributed since 1909 occupied between 70 percent and 80 percent of the total oat acreage of the country. Forty of the 57 new varieties are registered as improved kinds, and have an average potential yield increase of 11 percent. As with wheat, however, the improvement is difficult to detect in the harvested yields.

The average yield between 1909 and 1914 was 29.2 bushels, as against 29.8 in 1927–31. The wide year-to-year fluctuation prevents discovery of specific trends. Increases appear to have occurred in the western dairy area, the middle eastern area, and in some minor sections. Elsewhere, trends are uncertain.

Improvement of Cotton Varieties [12]

Spread of the boll weevil caused a radical change in cotton varieties. The better varieties grown previously were mostly slow-maturing, and were hard hit by the weevil. They were replaced by early-maturing varieties with shorter staple. With this set-back, it has taken years of cotton breeding at the United States and State experiment stations to produce and make available new varieties with longer staple and resistance to the weevil. As a consequence, there have been rapid changes in varieties, and marked shifts were reported by farmers interviewed in the field study made by the National Research Project.

Many improved cotton varieties have been lost because of the prevailing use of gin-run seed. In practice, each farmer gets part of the seed from the farmer who preceded him at the gin, and part of his seed is mixed with that of the one who follows. As a means of overcoming the resulting deterioration of varieties, one-variety communities have been fostered. The first was started in Arizona in 1912, but little progress was made until 1931, when the plan was taken up more actively by the United States Department of Agriculture. It was estimated that by 1937 there were more than 500 of these communities growing upwards of 2 million acres of selected varieties of cotton.[13] Besides higher yields, premiums of 1

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[10] See R. B. Elwood and Others, *Changes in Technology and Labor Requirements in Crop Production: Wheat and Oats* (WPA N. R. P. Report No. A–10, April 1939), pp. 84–86.

[11] T. R. Stanton, "Superior Germ Plasm in Oats," *Yearbook of Agriculture* (U. S. Dept. Agr., 1936), pp. 381–7.

[12] From W. C. Holley and Lloyd E. Arnold, *Changes in Technology and Labor Requirements in Crop Production—Cotton* (WPA N. R. P. Report No. A–7, Sept. 1938), pp. 64 ff., and other indicated sources.

[13] Records of Cotton Division, Bureau of Plant Industry (U. S. Department of Agriculture, July 1937).

to 2 cents a pound were obtained for the higher quality of cotton from such communities.[14]

Since 1928, when data on length of staple of cotton produced in the United States first became available, the average staple length for American Upland cotton has shown a pronounced increase from 0.949 inch to 0.986 inch.[15] The greatest improvement has been in the eastern cotton area. This constitutes one of the more outstanding achievements of plant breeding during the period studied.

Variety improvement has been important with minor crops as well as with major ones. With potatoes and sugar beets, avoidance of certain diseases have been primary considerations, but higher yields have also been obtained from the improved varieties. With lettuce and sweetpotatoes shifts in varieties have meant improvement in quality. Thus, plant breeding has been of consequence in several different ways which cannot all be evaluated separately.

CHANGES IN CULTURAL OPERATIONS

Most of the changes in the fundamental operations of crop production have been of three types. Some were designed to simplify crop production, that is, to provide conditions favorable to plant growth by easier and less laborious routes than those previously followed. A potentially important shift has occurred in the theory of the purpose of cultivation. At the beginning of the period it was believed that conservation of soil moisture by frequent cultivation was of importance in maintaining yields. More recently it has been found that crops grow just as well, under most conditions, with less frequent cultivation, provided the weeds are prevented from growing.[16] As yet, however, this discovery seems to have made but little difference in the number of times that farmers actually cultivate, though it may bring a reduction of labor later on.

Other simplifications of the process of crop production have taken place as farmers have scrutinized their operations and rejected those that apparently were not justified. Thus, the amount of hand-hoeing, replanting, and thinning of such crops as corn, has been reduced.

A second change is concerned with the control of insect pests and diseases, through the treatment of seed corn, cotton, or small grain to destroy seed-borne disease organisms, a development since 1920. Dusting of the growing cotton crop to control the boll weevil is a similar development.

Changes have occurred in technical methods to obtain superior results from the same operations. Examples are methods of fertilizer placement and changes in formulae for fertilizers, spray materials, etc.

A related innovation is the improved methods of harvesting or utilizing crops on the farm. The shift to the use of corn silage has developed very largely since 1909. During the late 1930's experiments were made with methods of harvesting hay crops in the green form, which may affect either labor requirements or the amount of product.

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[14] C. B. Doyle, "Cotton Standardization in One-variety Communities Essential," *The Cotton and Cotton Oil Press*, 38 (13) : 28, 1937.

[15] *Grade, Staple Length, and Tenderability of Cotton in the United States, 1928–29 to 1933–34* (U. S. Dept. Agr. Statis. Bul. No. 52, 1936), pp. 17–22 ; *Grade, Staple Length, and Tenderability of Cotton in the United States, 1928–29 to 1936–37*, July 1937), pp. 22–23.

[16] See WPA N. R. P. Report No. A–5, *Corn*, pp. 56–58, and Report No. A–57, *Cotton*, pp. 39–40.

LOSSES FROM CROP DISEASES AND INSECT PESTS

Most of the improvements in crop varieties and in soil management during the last quarter century have been offset either by soil depletion or by losses from diseases or insects. In some cases intensive cropping has facilitated the spread of disease, particularly when the same crop is planted in successive years, and several serious new pests, such as the cotton boll weevil and the European corn borer have infested major producing areas since 1909.

The coming of such pests frequently has cut yields and the acreage planted to the affected crop. Where the pest is an insect that is present each year, it may be possible to develop natural enemies or parasites to hold it in check; or else a well-defined routine measure, such as the use of insecticides in spraying fruits, may keep down losses, though at the cost of additional labor.

Crop Losses Caused by Diseases [17]

It cannot be said on the basis of available figures that there has been any very definite trend toward higher or lower crop losses from disease during the period since 1919 (table 33). Wheat losses declined from an average of 11.2 percent of the crop in the first of the three periods shown, to 8.2 percent in the second, and then to 5.9 percent in the most recent period (if we omit losses in the epidemic year 1935). If 1935 be counted, however, losses in the last 6 years average 10.3 percent. Barley and oats show a small and probably insignificant increase, while losses of corn rose from 8.0 percent of the crop in the first period to 13.2 percent in the last.

Table 33.—*Percentage loss of crops from diseases by 6-year periods, 1919–36*

Crop	1919–24 [1]	1925–30 [2]	1931–36 [3]
	Percent	*Percent*	*Percent*
Wheat	11.2	8.2	[4] 10.3
Barley	5.0	6.0	[5] 7.2
Oats	6.3	8.3	[6] 8.4
Corn	8.0	9.1	13.2
Potatoes	19.4	20.1	18.9
Sweetpotatoes:			
Field diseases	10.2	9.0	9.4
Storage diseases	13.2	12.3	13.3
Dry beans	9.6	7.7	8.1
Cotton	14.0	13.4	16.4
Apples	15.6	12.8	14.1
Peaches	13.4	10.0	10.6
Tomatoes:			
For manufacturing	----------	----------	12.5
For market	----------	----------	16.3
Snap beans:			
For manufacturing	----------	----------	[7] 5.4
For market	----------	----------	[7] 16.9
Green peas:			
For manufacturing	----------	----------	[7] 5.7
For market	----------	----------	[7] 8.7

[1] *Plant Disease Reporter* (U. S. Dept. Agr., Bureau of Plant Industry), Supplement 43.
[2] *Ibid.*, Supplements 49, 56, 64, 83. [3] *Ibid.*, Supplements 87, 89, 94, 100.
[4] If we omit the year 1935, when there was an unusually severe rust epidemic, the average for this period will be 5.9 percent.
[5] Omitting 1935, the average would be 5.0 percent. [6] Omitting 1935, the average would be 7.1 percent.
[7] Average for 1934-36, only years for which data are available for these items.

[17] For more complete discussion see the following WPA N. R. P. Reports on Changes in Technology and Labor Requirements in Crop Production: No. A–4 *Potatoes*, pp. 24–31; No. A–5, *Corn*, pp. 19–25; No. A–7 *Cotton*, pp. 86–95; No. A–10, *Wheat and Oats*, pp. 78–83, 86–88.

The few figures available on more important truck crops since 1931 show relatively high losses on the fleshy and perishable vegetables. Also, they show higher losses on truck crops raised for marketing in the green state than for those raised for canning, since the latter are ordinarily raised under more favorable climatic conditions or are exposed only for short periods to the hazards of shipping and storage.

Treatment of seed with disinfectants has become highly important as a means of controlling certain plant diseases, particularly since 1920. Previously formaldehyde and other liquid disinfectants sometimes were used to control certain seed-borne diseases of small grains, potatoes, and other crops, but more recently disinfectant dusts, particularly organic mercury compounds, have come into use for small grains, corn, and cotton seed. Corn yields have been increased by this treatment where such disease organisms were present, by 2 to 4 bushels per acre. Cotton also is subject to seed-borne diseases, and recently practices of delinting the seed with sulphuric acid, or of applying seed disinfectants have increased. At least a part of the disease loss of 13 percent to 16 percent since 1919 can be avoided by this treatment. The soil-borne diseases of cotton and of other crops may often be controlled by the practice of crop rotation so that the disease organisms die out before the susceptible crop is planted again.

Notable success has been obtained in breeding disease-resistant varieties of cotton, potatoes, and wheat, as well as various minor crops. One more of the diverse channels of attack on crop diseases is in the extermination of plants which serve as hosts to disease. Black stem rust of wheat is most commonly spread by means of spores from the common barberry, where the organism passes one phase of its life cycle. Consequently State and Federal agencies have been waging an active campaign, since 1918, to eradicate the common barberry in 13 north central States. Although the work is not yet complete, losses from this disease have been reduced in most years to 2 or 3 million bushels a year. This may be compared with an average loss of 58 million bushels in the 5-year period ending with 1920 (which contained one epidemic), and with average losses of 18 million bushels in the period ending with 1925. In an occasional year an epidemic still occurs from spores carried directly from the southern hard winter-wheat region where they are able to live through the winter in the less destructive red stage.

As farmers become more generally aware of the benefits to be gained from the various means of crop disease control, some increase is likely to occur in production, and at a net saving of labor per unit of output. Nevertheless new diseases are sometimes introduced or old ones spread to new areas. Consequently, the net gain to be expected from disease-control methods must be definitely less than recent percentages of loss shown in table 33.

Crop Losses From Insect Pests

Heavy losses from insect pests vary from year to year, depending on weather conditions as they inhibit or favor insect life, and on the occasional introduction of new insects. The usual history of such a new pest is one of increasing infestation and severe damage to the plants attacked until the insect has spread over the entire area favorable to its existence. The natural enemies that prey upon

the insect meanwhile may multiply spontaneously until a new biological balance is established after a lapse of a few years; or such parasites may be distributed by entomologists; or methods may be developed for combating the pest by insecticides or by changes in cultural methods. Sooner or later farming methods are adjusted to the presence of the insect and losses are usually reduced enough so that farmers can continue to produce the crops affected, even though at added cost for pest control.

The Cotton Boll Weevil

The cotton boll weevil ordinarily causes the greatest loss of any insect pest. The weevil was first reported in the United States in 1892 in southern Texas. In 30 years it spread northward and eastward to the Atlantic seaboard, as is shown in figure 17. In each new area invaded, it caused a sharp decline in cotton yields, and, to a

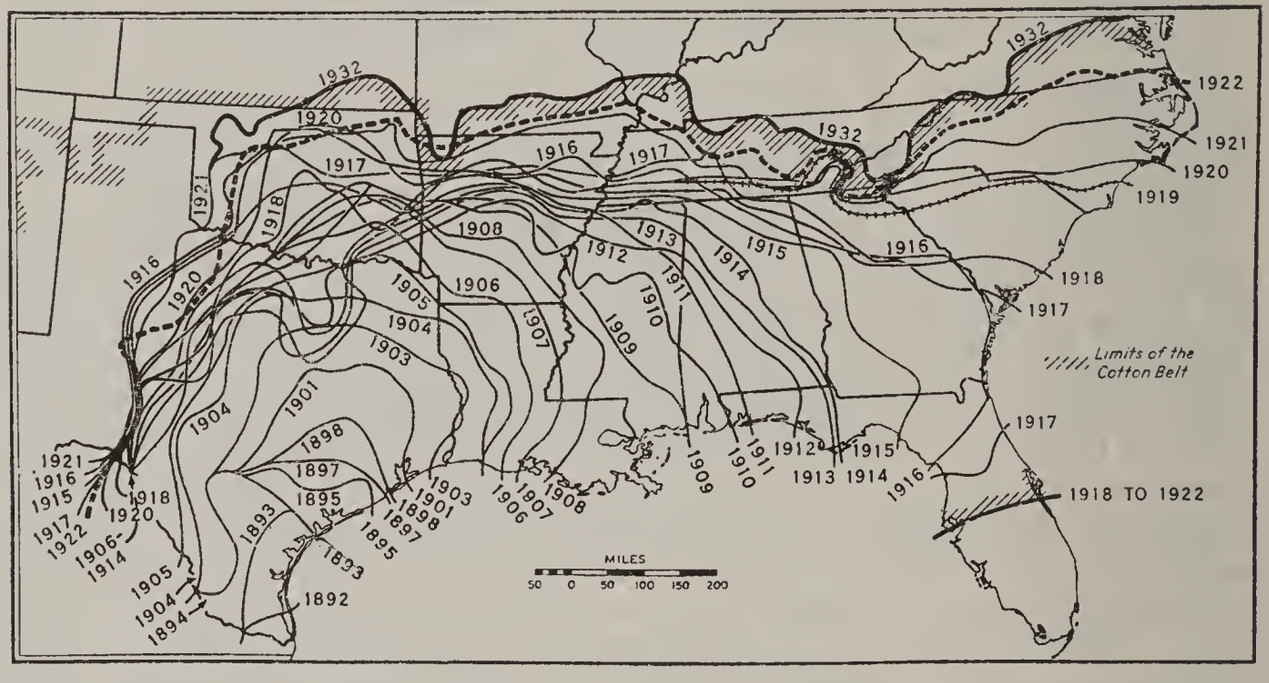

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Figure 17.—Spread of the cotton boll weevil, 1892–1932.

Source: Bureau of Agricultural Economics.

lesser degree, in acreage of the crop. The greatest damage occurred in 1921 and was estimated at more than 30 percent of the United States cotton crop. The average loss from 1916 to 1928, however, was just under 15 percent.[18]

Three or four years after the invasion of the weevil into an area there was usually some recovery, both in yields and in acreage. This was made possible by various influences, not all of which are fully understood. For one thing, as the weevil caused the greatest damage to late varieties, farmers were forced to change to earlier maturing types and to earlier planting. There were also various changes in cultural practices, of which perhaps the most important was closer spacing of the cotton plants in the row and dusting the plants with calcium arsenate. Relatively few farmers, however, carry out anything like a consistent and thorough-going program of dusting, according to data obtained in the 1936 N. R. P. field study.

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[18] J. A. Hyslop, *An Estimate of the Damage by Some of the More Important Insect Pests in the United States* (U. S. Dept. Agriculture, Bureau of Entomology, 1930), p. 21.

Other insects cause an average estimated loss of approximately 4 percent of the United States cotton crop.[19] The most serious are the cotton leafworm and the cotton bollworm, also known sometimes as the corn earworm.

Insect Pests of Corn and the Small Grains

The corn earworm causes an estimated annual loss of 4 percent of the United States corn crop. The chinch bug, another destructive insect, destroys about 7 percent of the corn, wheat, and oats in the southern Corn Belt, from Indiana to Kansas.[20] The worst outbreaks occur in hot, dry summers that follow mild winters.

The European corn borer was first reported in this country in 1917; in 1936, however, it infested only about 250,000 acres of corn. The damage it will cause when it reaches the more intensive corn-producing areas is still uncertain. Control of the borer will require additional labor in order to destroy or to cover completely all the old corn stalks in which the insects live through the winter.

The most serious insect threat to wheat, the Hessian fly, was responsible for average losses of about 48 million bushels between 1920 and 1928, or about 6 percent of the United States crop. Crop rotation, thorough seedbed preparation, and delaying the planting of winter wheat until after the fly-free date, when the average daily temperature falls below 50° F., are means of control.

Insects Attacking Other Crops

Other less important insect pests attacking major crops include the Colorado potato beetle, which is combated more effectively than it was in 1909; the Japanese beetle, imported during the period studied, which attacks a wide range of plants in the Eastern States and the codling moth, a destructive pest in fruit orchards for many years. Commercial apple growers frequently produced satisfactory crops with three or four sprayings around 1910, but since then 10 or 12 applications have become necessary in major producing regions. Labor requirements have been greatly increased, but with this amount of attention, the apples are of higher quality than formerly.

The Shifting War Against the Pests

Two general observations grow out of this discussion of the farmers' fight against plant pests and diseases: (1) outbreaks by new pests, at least by pests new to a given area, are a constant threat. The severity of such infestations and the damage they will cause are seldom predictable with any degree of accuracy; (2) even after methods of control are devised by man, or a new biological balance is brought about by nature, added labor is usually required to guard against fresh outbreaks and heavy damage. Such control as is finally obtained sometimes involves enough added cost to restrict the size of the enterprise. This is illustrated in the apple-producing sections of the northwest, where the cost of pest control has probably been the principal reason for decline in apple production during the past couple of decades.

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[19] Hyslop, *op. cit.*, p. 5.
[20] Hyslop, *op. cit.* pp. 6–7.

Usually, the number of pests and the severity of infestations increase with intensity of production. So far, improvements in methods of control seem merely to have offset the loss from more widespread pests and diseases. Even the avoidance of greater losses, however, must be regarded as an accomplishment. For the future, it appears that there are possibilities, if not actual probabilities, of reducing such damage. On the other hand, there is always the unpredictable chance that some new pest will appear to offset past gains, if not to surpass previous damage.

CHANGES IN THE TECHNIQUES OF ANIMAL PRODUCTION[21]

Employment in livestock production may be affected directly by the methods used in handling the animals, or indirectly by factors affecting the production per head. With greater production per head, less labor in total is needed to produce feed and take care of the livestock required for a given total output. In chapter VIII the changes in direct labor used in caring for livestock will be discussed. Here will be summarized the technological changes involving feed requirements and production per head: the improvement of the various breeds with a view to higher productive capacity of the animals or greater efficiency in converting feed into milk, pork, or beef; discoveries in animal nutrition that result in economy of feed consumption, and the control of animal diseases.

BREEDING AND SELECTION OF LIVESTOCK

Pronounced progress has been made since 1909 in breeding and selecting livestock for greater production. This has been particularly true of dairy cattle and of poultry, and to a lesser degree, of swine and beef cattle. The same course of development of breeding methods has been followed, in general, for each type of livestock. Earlier attempts at improvement usually consisted of selection of breeding animals on the basis of their individual conformation or appearance. This type of selection was strongly promoted, and is still promoted to a lesser degree, by the livestock breed associations which have emphasized certain points of conformation in the show ring.

The second step has been selection on the basis of performance of the breeding animals. Thus, the offspring of high-producing cows have been retained, while calves from low-producing ones have been rejected. This method has been much more successful in raising production to a moderately high level than has selection on the basis of conformation. Above this level, however, further gains were more difficult to achieve, until application of the third method, which involves determining the ability of breeding stock to transmit high-producing capacity to their offspring, and then using the offspring of proved stock for further breeding. This method requires much more time and a wider coordination of effort than the two earlier stages, but appears to be leading to superior results.

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[21] The material on livestock technology was prepared, chiefly, by A. A. Lewis in a series of four unpublished manuscripts, *Changes in Technology and Labor Requirements in Livestock Productions: Dairying, Poultry, Hogs, and Beef Cattle.*

Improvement of Dairy Cattle

It has been estimated that from 40 percent to 50 percent of the variation between individual cows in milk production and between 60 percent and 70 percent in butterfat production is attributable to differences in heredity.[22] The remainder comes largely from feeding and environment.

A relatively small percentage of the dairymen of the country keep records of production of their individual cows. The rest depend on casual observation of daily production or on conformation for selection of the cows to be used as breeding stock. Conformation has also been very important as a basis for selection in the show ring and has had a commercial value because farmers are willing to pay more for cows of physical beauty, certain aspects of which are associated in their minds with high production. It has been demonstrated, however, that the correlation between conformation as judged in the show ring and actual production is relatively low.[23]

Cattle breed associations have spent much time and energy in promoting their various breeds, and the spread of registered cattle has, in general, been beneficial. The influence of registered stock has permeated the dairy-cattle population, particularly from the pure-bred bulls which are used in many herds of grade cows. Only 3.9 percent of the dairy cattle of the country were registered in 1920, however, and only 4.7 percent in 1935.[24]

Beginning about 1870 and increasing in importance for almost a half century, the dairy-cattle breed associations fostered official bovine tests, but these were applied only to the best producers and were of little practical importance in improving the dairy stock.

In 1906 a Dairy Herd Improvement Association was started in Michigan. This form of cooperative testing was of increasing importance until in 1930 there were 1,143 associations with 507,549 cows under test, amounting to 2.3 percent of all cows kept primarily for milk production. Such an association employs a tester to visit each herd once a month. On each visit he weighs, tests, and records the milk production of each cow, estimates feed consumption, and advises the farmer on feeding and management of the herd. The effectiveness of this method in raising the level of productivity of the herds under test is shown by the fact that the average butterfat production of Dairy Herd Improvement Association cows rose from 247 pounds in 1920 to 303 pounds in 1930, and to 322 pounds in 1935.[25]

The progeny testing of bulls is being practiced for the more difficult task of raising production above the level to which it has been raised in cow-testing herds. The bull is of particular importance in herd improvement, since he represents half of the genetic influence on future generations of cattle. In 1936 the United States Department of Agriculture conducted a survey of all herds which had enough super-

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[22] J. W. Gowen, *Milk Secretion* (Baltimore: Williams & Wilkins Co., 1924), pp. 153–336; Mogens Plum, "Causes of Differences in Butterfat Production of Cows in Iowa Cow Testing Associations," *Jour. Dairy Sci.*, 18 (12): 811–825, 1935.

[23] J. W. Gowen, "Studies on Conformation in Relation to Milk Producing Capacity in Cattle, II. The Personal Equation of the Cattle Judge," *Jour. Dairy Sci.*, IV, No. 5 (1921), 359–74.

[24] A. B. Nystrom, *Dairy Cattle Breeds* (U. S. Dept. Agr. Farmers Bul. No. 1443, 1925), p. 1; *op. cit.* (1935 revision), p. 1

[25] *Dairy Herd Improvement Associations in the United States Active January 1, 1937* (Dairy Herd Improvement Association Letter, 1937), Vol. XIII, No. 2.

vised records to prove two or more sires. Records were analyzed for more than 1,000 herds, and comparisons of enough dam-daughter pairs were obtained to prove 2,844 bulls. The testing of bulls, however, requires an extensive and continuous investigation. Also it requires keeping the sires longer, until they have enough producing daughters to demonstrate their worth and then until maximum utilization can be obtained from the outstanding bulls.

Improvement of Poultry

The improvement of poultry has followed a course very similar to that of dairy cattle. First came the selection of breeding stock on the basis of individual appearance. This was followed by recording the production of the individual, and later by a study of the ability of individuals to transmit high productivity to their offspring.

Poultry may be raised either for egg production or for meat, and different types of birds are required for these two objectives. Since 1909 there has been a general shift toward the light breeds of chickens, typified by the Leghorns, and away from the heavier Barred Rocks and Rhode Island Reds which produce more meat and fewer eggs.

The earliest of the effective measures for poultry breed improvement was by means of the trap nest. The practice, however, was expensive and was never adopted by very many poultrymen. In order to authenticate records of high egg production, official egg-laying contests were started in Connecticut and Missouri in 1911, and permitted poultry breeders to send a small number of pullets to a central location where their egg-laying ability could be tested. In 1930–31 there were 30 such contests in continuous operation under supervision of State authorities.[26]

To permit production of high-producing breeding stock for wide dissemination, supervision of trap-nest records in individual poultry plants was begun in 1926, and was being carried on in 23 States 10 years later.[27] This program has had appreciable effect in raising the level of production of the flocks participating.

The next step in improvement was progeny testing. As with dairy cattle, a large part of the useful life of the breeding bird elapses before its value as a breeder is determined. A close correlation has been found, however, between the production of a pullet during its first 90 days of production and its average annual production. This permits a saving of a year in determining productivity.

The poultryman can also improve the productivity of his flock by culling out low-producing birds. There are correlations between lateness of molt, pigmentation of the fowls, conditions of the pelvic bones, and so on, and the productivity of the hens, and the farmer is able to cull his flock on the basis of these characteristics. Data obtained in the N. R. P. field study of 1936 show that the practice has become widespread. It undoubtedly lowers both the labor and the feed consumption per egg produced, although it raises somewhat the cost per bird retained.

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[26] W. C. Thompson, *A Practical Poultry Breeding Improvement Program* (N. J. Agr. Exp. Sta. Bul. No. 527, 1931).

[27] *Extent of Participation in the National Poultry Improvement Plan* (unpub. data; U. S. Dept. of Agr., for year ending June 30, 1936).

Changes in Swine and Beef Cattle

There are certain special difficulties in recognizing breeding animals whose offspring will make the most economical gains and will be of a type most desired for meat: (1) The farmer loses sight of the meat animals he has raised after they leave his farm, as they are slaughtered along with hundreds or thousands of others at some distant packing plant; (2), even though the increase of registered stock has undoubtedly raised the quality of farm stock, many of the characteristics of hogs and beef cattle which have received most attention by professional breeders and in the show ring prove to be merely trade-marks for the respective breeds, such as color, markings, shape of head or horns, etc.

Selection of hogs for large litters by farmers and professional breeders has affected the average size of litter raised. For the whole country the average number of pigs saved per litter increased 15.7 percent from 1922–24 to 1929–31. The increase in the corn, western dairy, and small grain areas, where hogs are of particular importance, has been 18 percent or 19 percent. Part of the increase, however, has undoubtedly been caused by better management and better feeding practices.

Relatively little has been done in a systematic or scientific way to improve the stock of breeding hogs until recently. Even the agricultural experiment stations were found to be giving relatively little attention to genetic improvement of swine,[28] but since 1930 several stations have begun work of this type. Some of them have developed means by which sample pigs from litters may be sent to a central point to be fed and then slaughtered in competition with pigs from litters raised by other breeders. Great variations have been found in rate of gain and in amount of feed required per hundred pounds of gain.

One important development is cross-breeding corresponding to production of hybrid corn. This has been practiced for some time in a rather hit-or-miss manner, but has been promoted only recently in a systematic way. It involves breeding sows of one breed to boars of another, and when the two breeds possess desirable characteristics, results in offspring with a hybrid vigor which make rapid and economical gains. Such pigs have been found to be larger at birth and to excel purebreds in rapidity of gains by 10 percent to 20 percent.[29]

To improve the beef breeds over the present grade of animals, fundamental genetic discoveries will apparently be required. Early studies supported the belief that the blocky type of beef animal made the more rapid and economical gains. In 1927, however, the Wyoming Agricultural Experiment Station published results of an experiment in which very rangy calves excelled the popular, blocky type.[30] Calves with relatively large paunches, large chests, wide hips, and long bodies appeared to be most economical in the use of feed. The grading of the carcasses, however, showed but little

[28] H. C. McPhee and O. G. Hankins, "Swine—Some Current Breeding Problems," *Yearbook of Agriculture, 1936* (U. S. Dept. Agr., 1936), pp. 888–892.

[29] P. S. Shearer, John M. Evvard, and Others, *Crossbreds Versus Purebreds in Producing Market Hogs* (Iowa Agr. Expt. Sta. Leaflet No. 20, 1926).

[30] F. S. Hultz, *Type in Beef Calves* (Wyoming Agr. Expt. Sta. Bul. 153, 1927).

correlation with the economy of gain, indicating that the two are distinct characteristics; that is to say, the best quality may not be obtained from the animal that makes the most economical use of feed. Other experiments have supported these findings.[31] Thus, more extensive investigation is clearly needed to discover means of combining the two sets of desirable characteristics.

DISCOVERIES IN ANIMAL NUTRITION

Discoveries in animal nutrition early in the century laid the foundation for great progress in economical animal production, as well as for the better maintenance of human health. These discoveries had to do with the needs of animals for three types of substances—proteins, minerals, and vitamins.

It was found that rations which were alike chemically might differ greatly in feeding efficiency. The value of the protein in food was discovered to depend on a balance of digestive products called amino acids, of which about 20 have been found and of which some 8 or 10 appear to be indispensable to growth. Thus, quality of the protein is as important as quantity, and adding a small amount of a missing element may greatly increase returns from an otherwise satisfactory ration. Most of the cereal grains are now known to be deficient in one or more of the essential amino acids, which must, therefore, be provided from some other source.

Protein Needed by Livestock

Protein is relatively expensive, compared to the carbohydrates that make up the greater part of the ration. The need for an ample supply of protein has been emphasized for so long and so strongly, however, that many dairymen now appear to be feeding more of it than is needed. Investigations show that after body-maintenance requirements are met, only 1.25 to 1.5 times as much protein is needed by the cow as is contained in the milk. This is only half as much as was formerly recommended.[32] The large increase in production of alfalfa hay, rich in protein of good quality, has done much to overcome any former deficiency. This relatively cheap source, together with the revised opinion of biological chemists as to the cow's requirements, means worthwhile saving in the dairy farmer's feed bill.

In the production of beef cattle, on the other hand, protein has become relatively more important than formerly. A quarter century ago the typical fattening steer was 2 years old and had already made his growth on pasture either on the range or on a Corn Belt farm. More recently a shift toward fattening cattle at earlier ages has been pronounced. Experiments have shown that 600-pound calves require over a third more protein per 100 pounds of gain while being fattened than do thousand-pound 2-year olds. The younger cattle also require a

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[31] J. L. Lush, *The Relation of Body Shape of Feeder Steers to Rate of Gain, to Dressing Percentage, and to Value of Dressed Carcass* (Texas Agr. Expt. Sta. Bul. No. 471, 1932).

[32] F. B. Morrison, *Feeds and Feeding* (20th ed. unabridged, Ithaca, New York, Morrison Publishing Co., 1936), p. 489; J. L. Hills, C. L. Beach and Others. *The Protein Requirements of Dairy Cows* (Vt. Agr. Exp. Sta. Bul. No. 225, 1922); E. B. Hart and G. C. Humphrey, "Can Home Grown Rations Supply Proteins of Adequate Quality and Quantity for High Production?" *Jour. Biol. Chem.*, XXXVIII (1919), 515–27.

longer period for fattening than do the 2-year olds, but they need less feed per 100 pounds of gain.[33]

Between 85 and 90 percent of hog feed is corn, and hogs consume between 40 and 50 percent of the corn grown in the United States.[34] With hogs, as with cattle, the tendency has been toward earlier maturity. This means a higher protein requirement, and corn is poor in protein. For hogs the most important sources of protein to supplement the grain are tankage and, in the western dairy area and Corn Belt, skim milk. Supplies of both are limited, and consequently much interest in finding cheaper vegetable sources has been aroused.

Lately it has been found that cottonseed meal can be used to a maximum of 9 percent or 10 percent of the ration, although it was formerly thought to be poisonous to hogs.[35] Soybean meal offers another promising new source of protein, though it is still too early to tell whether and to what extent it may be cheaper than the sources already available.

Vitamins in Animal Nutrition

The second great discovery in animal nutrition during the last quarter century was that of the vitamins and their function in the animal body. Six of these have been definitely established; vitamin B may contain at least four distinct compounds. Vitamins A, D, and G may be lacking in ordinary feeds, while vitamins B and E are plentiful in grain feeds. Alfalfa, other green feeds, and silage are cheap sources of vitamin A, the absence of which may cause lowered resistance to disease, retarded growth, and digestive disturbances. A shortage of vitamin D may cause lack of assimilation of calcium and phosphorus, resulting in rickets. In poultry this lack is responsible for weak egg shells and a low hatching rate. Cod-liver oil or other fish oils are used in the rations of poultry to supply the need. Animals on pasture also receive more sunlight and are thus able to form more vitamin D in their bodies and to avoid the diseases which result from a deficiency of this substance.

The Use of Mineral Supplements

The third discovery in livestock feeding is that growth may be seriously affected by a deficiency of mineral elements. In addition to salt, it has been found that calcium and phosporus generally need to be supplied, and sometimes other minerals. Appreciable increases in gains on hogs are obtained by supplying small amounts of inexpensive mineral mixtures in cases where there is a deficiency. The proportion of farmers who are feeding such supplements has increased notably in the more important hog-raising regions, as was shown in the National Research Project's Field Study in 1936, when the use of mineral

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[33] F. B. Morrison, *Feeds and Feeding* (20th ed. unabridged; Ithaca, New York: The Morrison Publishing Co., 1936), pp. 645, 1005.

[34] S. S. Bulkley and O. G. Hankins, "Trend in Hog Production is Toward Efficiency and Quality of Product," *Yearbook of Agriculture, 1933* (U. S. Dept. Agr., 1933), p. 252; C. E. Leighty, C. W. Warburton, and Others, "The Corn Crop," *U. S. D. A. Yearbook, 1921* (U. S. Dept. Agr., 1922), p. 164.

[35] F. C. Hale, *Cottonseed Meal as a Feed for Swine* (Texas Agr. Expt. Sta. Bul. No. 410, 1930); W. L. Robinson, *Cottonseed Meal for Pigs* (Ohio Agr. Expt. Sta. Bul. No. 534, 1934); Morrison, *op. cit.* (1936), pp. 884–6.

feeds for hogs was reported by 46 percent of the farmers interviewed in the corn area and the western dairy area, by 29 percent in the eastern dairy area, and by about 20 percent in the small-grain and cotton areas. It has been discovered recently that deficiency of these minerals may cause serious diseases in beef and dairy cattle as well as in hogs.

CONTROL OF LIVESTOCK DISEASES

Labor requirements in the production of our livestock products are strongly affected by the prevalence of livestock diseases. Infected animals cannot produce to full capacity and this means that labor and feed are wasted, or that more are required to obtain a given amount of product. The quality of the product is likely to be affected adversely by animal diseases, and in some cases, as with tuberculosis or Bang's disease of dairy cows, the infected animals are a menace to human health. Fortunately, considerable progress has been made in eradicating some of the more serious diseases, although this has been at a heavy cost of time and money.

Diseases of Dairy Cattle

Tuberculosis is estimated to have caused losses among livestock in the United States of $40,000,000 a year before systematic eradication work was begun.[36] The first survey of bovine tuberculosis was completed in 1922 and indicated an infection of 15 percent of the cattle in the eastern dairy region and an infection of 4 percent of all cattle in the country. Tuberculosis also occurs among poultry and hogs. An average of about 5 million swine infected with tuberculosis during the period 1928–30 was indicated with infection heaviest in the commercial hog-producing sections. Control of tuberculosis among hogs is largely a problem of eradicating it from farm poultry, and is not so serious a cause of loss as with dairy cows.

Among dairy cows the campaign for eradication of tuberculosis has been under way for two decades. Since 1933 progress has been more rapid because of the allocation of extra Federal funds to this work. The percentage of cows reacting to the tuberculin test declined from 3.3 percent in 1924 to 0.7 percent in 1937.[37]

Bang's disease, or contagious abortion, is the second great cause of loss among cattle. It is transmissible to humans as undulant fever. Cattle losses from this disease doubled between 1918 and 1928, reaching an estimated total of $50,000,000 annually.[38] The disease not only results in loss of the calf, but also reduces milk production following an abortion and causes an increase in mastitis, or infection of the udder. In 1934, Federal funds were made available to pay indemnities for condemned cows. By August 31, 1938, nearly 30 million cattle had been tested in over 2 million herds, and 1.6 million reactors were

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[36] Alexander E. Wight, "Eradication of Tuberculosis Among Livestock in the United States," *Proceedings of the Twelfth International Veterinarian Congress*, II, Sec. I (1934), pp. 33–34.

[37] Statistical Tables and Maps Showing Progress of Tuberculosis Work Among Livestock in the United States (U. S. Dept. Agr. mimeo., November 1, 1937), p. 11; *Agricultural Statistics, 1938* (U. S. Dept. Agr., 1938), table 472, p. 341.

[38] John R. Mohler, "Two Great Animal Plagues, Abortion Disease and Bovine Tuberculosis," *Cornell Veterinarian*, 18 (4) : 358–366, 1928.

eliminated. Considerable time and money still will be required to get rid of the disease.[39]

Mastitis, widely prevalent among dairy cows, may be caused by any one of several organisms. It has been estimated that about a quarter of the cows culled from dairy herds are sold because of udder trouble.[40] The disease reduces milk production and causes undesirable chemical changes in the milk.

Disease Control and Quality of Dairy Products

Improvement in quality of milk and other dairy products has done much to increase their consumption. The danger from disease organisms and the loss of milk and cream from souring have caused cities and towns to adopt more strict regulations over the methods of dairy production. Inspection has been extended to farms as well as to milk distributors, and pasteurization has come to be generally practiced. This regulation requires the employment of a considerable corps of inspectors, whose work should be regarded as a part of the total labor required in dairy production.

Diseases of Beef Cattle

Heavy losses have occurred among beef cattle because of Texas or tick fever, blackleg, and screwworms. Tick fever was estimated to cause an annual loss of $40,000,000 in 1906, partly from death of animals and partly from lowered weight and quality of infected cattle. At that time 985 southern counties were under Federal quarantine because of tick infection. From 1906 to 1936 an active campaign reduced the infested area to 28 counties in Texas and 6 counties in Florida. The screwworm is the larva of a fly which lays its eggs in wounds of cattle or any other warm-blooded animal. The maggot burrows into the flesh, where it lives for 1 to 2 weeks. Screwworm losses have been spreading and are becoming more serious, therefore, more labor will be required to control them.

Blackleg is an acute infectious disease affecting young cattle, and occasionally sheep and goats, which may cause the death of infected animals within 12 to 36 hours. A blackleg vaccine, distributed by the United States Department of Agriculture since 1897, gives immunity for a few months. Vaccination must be continued year after year, however, since pastures once infected are seldom freed from the organism.

Diseases of Swine

Hog cholera, the most serious disease of swine, has caused heavy losses for many years, particularly in the Middle West and the South, with an average loss in the last 50 years estimated at $50,000,000. During the 1930's about 2.8 percent of the hogs of the country died from cholera.[41] Farmers have come more and more to depend on immunization by serums originally developed by the United States

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[39] *U. S. Reports Progress Against Bang's Disease in Cattle* (U. S. Dept. Agr., press release, November 25, 1936); *Summary of Bang's Disease Control Program July 1, 1934 to January 31, 1937* (U. S. Dept. Agr., Bur. Animal Industry).

[40] J. H. Jacobson and T. M. Olson, *The Detection of Mastitis in Dairy Herds* (S. Dak. Agr. Expt. Sta. Bul. No. 290, 1935), p. 4.

[41] M. Dorset and U. G. Houck, *Hog Cholera* (Rev. ed.; U. S. Dept. Agr. Farmers' Bul. No. 834, 1928 and 1937).

Department of Agriculture in 1908–09. The National Research Project. field study found that about 70 percent of the farmers interviewed in the corn area had their pigs innoculated against hog cholera annually, as compared to 11 percent to 32 percent in other areas.

Hogs are affected by several species of internal parasites which prevent normal growth and thereby lead to a loss of feed and labor. The most effective method of avoiding losses is through strict sanitation, particularly among sows and young pigs.[42]

Diseases of Poultry

Chickens and hens are subject to a large number of diseases. The United States Department of Agriculture found that the mortality among the chicks of crop reporters in 1928 was 25.8 percent, and that among laying fowls 9.7 percent.[43] A reduction of about 5 percent for the country as a whole by 1934 in the losses of chicks was indicated.

Among diseases of poultry are pullorum disease, coccidiosis, and fowl-pox. Pullorum disease (bacillary white diarrhea) was reported to be the most serious disease of poultry during the first quarter of this century. Use of the agglutination test permits detection and removal of infected breeding stock and has greatly reduced losses from this disease.

Coccidiosis was the second serious disease among chicks during the early part of the period under consideration, and sometimes wiped out entire flocks. The disease is transmitted from one chick to another and the causative agent is carried over in the soil from year to year. Sanitation is the principal means of control but favorable results are also reported from feeding buttermilk or sour milk.

Fowl-pox affects other poultry as well as chickens. Birds which recover have been found to have immunity. Vaccination of the fowls with an attenuated virus has proved effective as a method of control.

Although most of the more serious diseases of chicks have been brought under a measure of control, mortality in the laying flock has increased, particularly in commercial poultry districts where large numbers of hens are kept continually in the same quarters. Sanitation is the principal means of reducing losses.

EFFECT OF TECHNOLOGICAL CHANGES ON LIVESTOCK PRODUCTION

What has been the effect on production of these technological discoveries? In general, they have tended to increase production per animal or to avoid higher feed or labor costs. It is not possible to measure the exact quantitative effects of individual developments because many of the discoveries have been adopted by farmers more or less simultaneously; and the rate of application of new practices has been very uneven and has lagged behind the scientific discoveries.

It is possible to appraise the aggregate change in production per animal, however, and to draw some inferences as to the relative

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[42] H. B. Raffensperger and J. W. Connelly, *The Swine Sanitation System as Developed by the Bureau of Animal Industry in McLean County, Illinois* (U. S. Dept. Agr. Tech. Bul. No. 44, 1927).

[43] S. A. Jones, *Method and Procedure in Estimating Production, Disposition and Income, Poultry and Eggs* (U. S. Dept. Agr., Bureau of Agricultural Economics, 1930), pp. 88–89.

importance of some of the principal technological discoveries. Average production of milk per cow increased from 3,802 pounds in 1909–13 to 4,529 in 1927–31 and 4,350 in 1937.[44] The increase was greatest in the dairy areas, where more attention has been given to improvement of the stock and to adoption of practices making for most profitable production. In the eastern dairy area the rise was from 4,551 pounds in 1909–13 to 5,367 in 1927–31, and in the western dairy area it was from 4,466 pounds to 5,298. In the corn and small-grain areas, which, in the aggregate, produce large amounts of dairy products, the improvement has been obscured by a shift from beef or dual-purpose cattle to cows of genuine dairy breeding. It should be realized, however, that in shifting to a cow specialized for milk production, a decline in production of beef follows.

Breeding a larger proportion of the cows to freshen in the fall rather than in the spring has probably had some effect in increasing total milk production for the year, and has changed the seasonal distribution so that more milk is produced in the winter when it is higher priced. Also production per cow has been increased by improved feeding practices and by the greater amount of silage fed per cow. The use of silage for dairy cows was just getting well started in 1909 and expanded greatly until some time in the 1920's. Adding this succulent feed, which also provided a supply of vitamin A, materially increased the output of cows previously fed during the winter on dry feed alone. Greater use of good quality legume hay also helped increase the production per cow. So did the provision of individual water cups in the stables on many farms, and the general improvement in feeding methods by better informed farmers.

Production of hogs has also become more efficient, both per head of the breeding herd and per 100 pounds of feed used. This improvement is difficult to measure because of shifts in practices. The number of sows and gilts on farms on January 1 was 13.0 million in 1909–13, 10.3 million in 1927–31, and 8.2 million during the years 1932–36 when hog production was cut sharply by drought and by the AAA corn-hog program. On the other hand, production amounted to 11.9, 16.0, and 13.7 billion pounds, live weight, for these three periods, respectively.[45]

The number of sows and gilts on farms on January 1, does not represent the number of breeding animals in the same sense as does the number of cows. Changes in the average dates of sale of old sows have been made, and more are bred for two rather than for only one litter per year. The rise of 15.7 percent in numbers of pigs saved per litter from 1922–24 to 1929–31 gives a better indication of the increased production per breeding animal.

Better feeding practices and more attention to sanitation have increased the rates of gains on growing and fattening pigs and have lowered feed cost. There is no way of telling the exact effects of these two sets of influences. Probably sanitation and disease prevention have played somewhat the greater part. Nevertheless, the wider use of protein supplements and of minerals have certainly increased pro-

[44] Raymond G. Bressler, Jr. and John A. Hopkins, *Changes in Size and Production of the Aggregate Farm Enterprise, 1909–36* (WPA N. R. P. Report No. A–6, 1938), tables A–95, A–96; also *Agricultural Statistics*, 1938, p. 341.

[45] Blessler and Hopkins, *op. cit.*, tables A–102, A–103.

duction, and it is clear that both of these practices have been adopted by many farmers since 1909. The practice of self-feeding was also developed during this period and has made for greater gains as well as for lower labor requirements.

Egg production per chicken on farms is estimated to have increased 33 percent from 1909 to 1937–38, or from 70 to 93 eggs per chicken.[46]

As has been stated, poultry production has been under the disadvantage of greater disease losses, particularly in the large commercial flocks of laying hens. Breeding stock of poultry now has a higher productive capacity than it had in 1909. Many important discoveries in methods of nutrition, as well as in management of the flock, have been made.

It should be emphasized that by no means all farmers have as yet adopted the improved practices discussed. Only a minority has made effective application of many of the new methods. Others have made only incomplete or ineffectual attempts, as with the partial adoption of measures of swine sanitation, where omission of a single step may result in the loss of practically all benefits. As more farmers learn the necessary methods, gains in production per animal or per unit of feed and labor may be expected to continue for many years, thereby reducing both the direct labor requirements, and also the labor and land needed to raise feed crops to produce a given amount of meat, milk, or eggs.

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[46] Geo. A. Sallee and others. *Changes in Methods and Labor Used in Poultry Production.* (WPA N. R. P. manuscript, table 3.)

CHAPTER VII. CHANGES IN THE INTERNAL ORGANIZATION OF THE FARM

Organization of the average farm in this country has changed only a little since 1909, except for an increase in the acreage of crops, a decline in the number of horses, and an increase in other livestock handled per worker. The average farm unit in 1929 contained about 13 percent more crop acres, and 10 percent more livestock units than in 1909. Capital goods, which at current prices were valued at about $1,000 more than in 1909 were utilized in 1929. In physical terms this capital exceeded that of 1909, chiefly in that it included mechanical power units as well as work animals.

The average farm unit in 1929 used about 8 percent less labor than in 1909. Thus, the change in fundamental organization consisted of a contraction in labor and some small increase in capital. With the improvements in available technology, it was possible for the average farm worker to handle 23 percent more acres of crops, and 18 percent more animal units in 1929 than in 1909.

The farm has been organized around the family labor supply, rather than around some unit of capital or of land, as was pointed out in Chapter III. This labor supply, however, has declined with the size of the family and averaged only 1.33 family workers per farm in 1935, as compared to 1.52 in 1909 and 1.35 in 1929 (table 34). The hired labor per farm remained practically unchanged from 1909 to 1929 at 0.46 to 0.48 workers per farm, and then declined during the depression to 0.38 per farm.

TABLE 34.—*Employment, crop acreage, and livestock per farm in the United States for specified years, 1909–35*

Item	1909	1920	1929	1935
Persons employed per farm: [1]	*Number*	*Number*	*Number*	*Number*
Total	1.99	1.82	1.83	1.71
Family	1.52	1.36	1.35	1.33
Hired	.47	.46	.48	.38
Capital goods [2]	*Dollars* [3] 1,441	*Dollars* 2,603	*Dollars* [4] 2,420	*Dollars* 1,664
Acres of crops [5]	*Acres* 51.5	*Acres* 57.2	*Acres* 58.2	*Acres* 51.4
Livestock units [6]	*Number* 10.4	*Number* 11.6	*Number* 11.5	*Number* 10.9

[1] Derived from WPA N. R. P. Report No. A-8, *Trends in Employment in Agriculture, 1909–36*, table 1 and appendix B.

[2] Including buildings, machinery, and livestock.

[3] 1910.

[4] 1930.

[5] Acreages or number of livestock per farm from WPA N. R. P. Report No. A-6, *Trends in Size and Production of the Aggregate Farm Enterprise, 1909–36*, appendix A, divided by number of farms from N. R. P. Report No. A-6, *Trends in Employment in Agriculture*, Appendix B.

[6] Animal units for the purpose of this table were estimated on the basis of numbers of animals requiring 100 hours of labor per year; 1 animal unit equalling: 0.7 milk cow, 4.0 head of cattle other than milk cows, 2,500 pounds live weight of live hogs produced, 20 sheep, 50 chickens, 1.5 horses or mules.

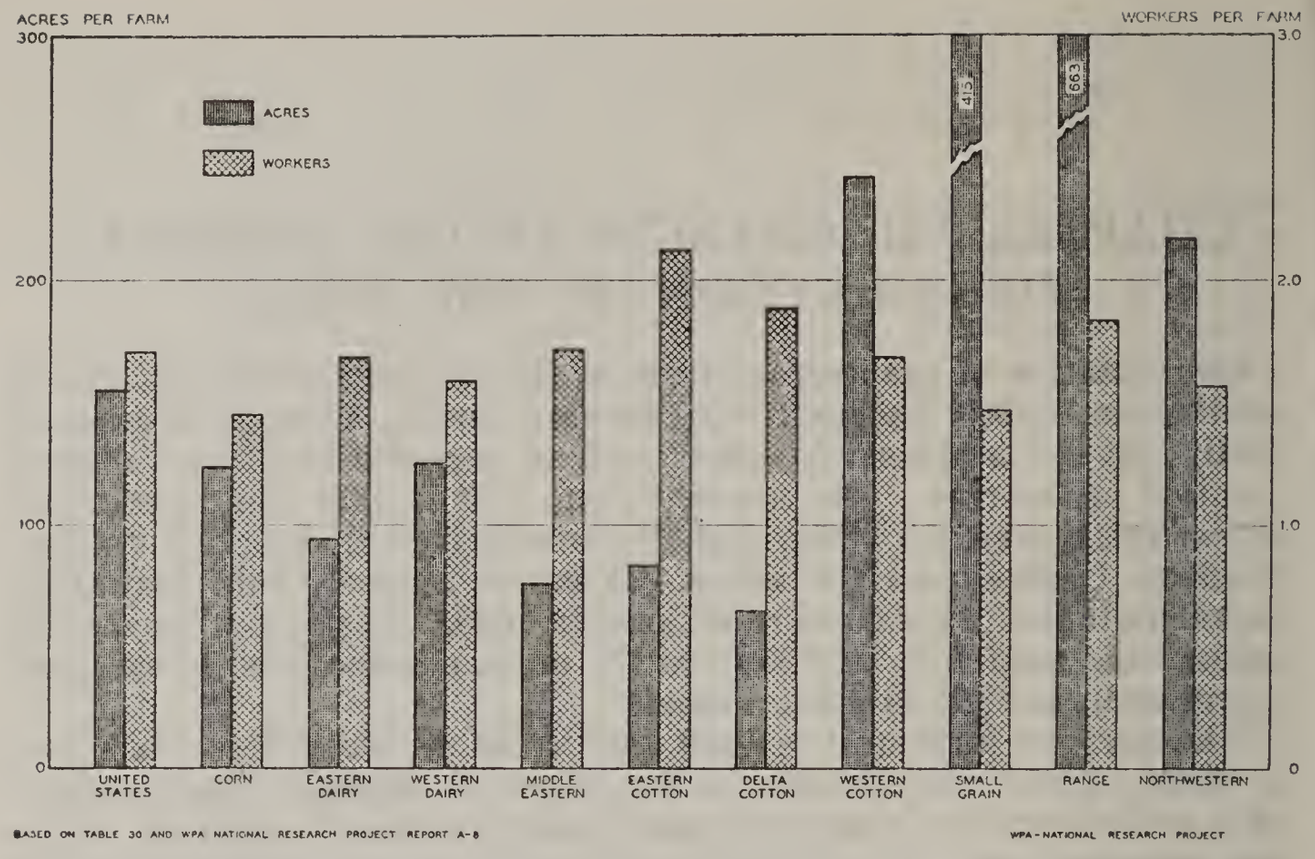

FIGURE 18.—Average number of workers per farm and average acres per farm, 1935.

Source: WPA N. R. P. Report No. A–8, tables 1, 3, 5, 7, 9, 11, 13, 15, 17, and table B–1 of Appendix B.

SIZE OF FARM

Size of the farm unit is important in determining the degree of application of labor-saving equipment and methods. This is particularly true of such mechanical equipment as combines and corn pickers and of some livestock equipment, like milking machines, but many labor-saving methods are not affected by the size of the farm. The saving in labor from the adoption of higher yielding crops or livestock and that from changing to more effective spray materials or more concentrated fertilizers can be obtained as readily on a small farm as on a large one. The greatest saving in labor during the last quarter century, however, has come from mechanization, and this is closely related to size.

Size of farm is most often expressed by its acreage. Labor, capital, and management are also essential elements of a farm, however. Thus, size might be measured in terms of any one or any combination of these elements. It might also be measured by the value or physical volume of farm products.

Acreage is the simplest and most common expression of size. For the United States, farms average about 160 acres,[1] but typical size varies widely between different parts of the country (table 35). The largest agricultural units occur in the range area where the average was 663 acres per farm. Of course, the ranches are much less than 10 times the size of the cotton farms or 5 times the size of the corn farms measured in any term but acreage. With a dry climate and with

[1] Derived from *U. S. Census of Agriculture: 1930* (U. S. Department Commerce, Bur. Census, 1932), vol. IV, ch. II, table XIV, pp. 892–903.

much rough land, production per acre on unirrigated land in the range area is relatively small.

Each area contains some parcels of land, classified as farms, which are under 3 acres and others of over 1,000 acres. For the United States as a whole, 71 percent of the farms, as classified by the census in 1935, were between 20 and 260 acres. In four of the areas, the middle eastern, eastern cotton, delta cotton, and California, 75 percent or more were smaller than 100 acres, while in the small-grain area 82 percent were larger than 100 acres. In the range area, where both small, irrigated farms and large ranches are found, 14 percent of the farms were under 10 and 21 percent over 500 acres.

The acreage per farm is closely related to the type of farming. In 1930, truck farms averaged 60 acres, poultry farms 62, and fruit farms 71 acres, among the minor farm types. Among the major types, cotton farms were smallest and averaged 72 acres. General farms averaged 138 acres, dairy farms 139, and cash-grain farms 352 acres.

Since 1909, distribution of farms by size has changed relatively little. If there is such an advantage in greater acreage, why are farms not consolidated until they are much larger than at present? Less efficient use of labor on large farms is one important reason. As more and more land is added to a farm of a given type, a point is finally reached where the farmer's management becomes too thinly spread. Returns fail to keep up with the added expense for the use of land. There are also other considerations. Perhaps the most obvious is the variation in ability of individual farmers. For another thing, it is difficult to change the size of a farm unit once it has been set up and equipped. The farmer who feels that he can handle additional land may not be able to buy or rent land adjacent to the farm he already has. Even if there is such land, the loss from abandoning buildings may deter consolidation for a long time.

TABLE 35.—*Percentage distribution of farms by size of farm and by farming areas, 1935* [1]

Item	Farming area											
	United States	Corn area	Eastern dairy area	Western dairy area	Middle eastern area	Eastern cotton area	Delta cotton area	Western cotton area	Small grain area	Range	Northwest	California
Total number of farms	*Thousands* 6,812	*Thousands* 909	*Thousands* 480	*Thousands* 600	*Thousands* 1.200	*Thousands* 690	*Thousands* 735	*Thousands* 714	*Thousands* 527	*Thousands* 176	*Thousands* 194	*Thousands* 150
Average acres per farm	*Acres* 155	*Acres* 120	*Acres* 94	*Acres* 125	*Acres* 76	*Acres* 83	*Acres* 65	*Acres* 242	*Acres* 415	*Acres* 663	*Acres* 216	*Acres* 202
Farms:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Under 10 acres	8	7	12	4	12	7	7	5	4	14	15	23
10–19 acres	10	6	9	4	13	11	23	7	2	8	12	18
20–49 acres	21	13	17	14	26	34	37	19	4	13	22	25
50–99 acres	21	23	25	27	24	25	17	23	8	11	16	11
100–174 acres	21	30	24	31	16	14	10	25	24	14	14	8
175–259 acres	8	13	8	12	5	5	3	8	12	5	5	3
260–499 acres	7	7	4	7	3	3	2	8	27	14	7	5
500–999 acres	3	1	1	1	1	1	1	3	13	12	5	3
1,000 and over	1	(2)	(2)	(2)	(2)	(2)	(2)	2	6	9	4	4

[1] *U. S. Census of Agriculture:* 1935 (U. S. Dept. Com., Bur. Census, 1936), vol. II, table XIII, pp. XXIV–XXIX.
[2] Less than one-half of 1 percent.

CHANGES IN MAKE-UP OF THE AVERAGE FARM

The principal shifts in the average farm are indicated by the figures in tables 36, 37, and 38.[2]

Changes in Organization in the Corn Area

In the corn area there was a decrease in the number of workers per farm of about 8 percent, all of which occurred in the hired labor (table 36). Value of capital goods increased nearly 80 percent when taken at current prices, but only one-fourth if adjusted for the difference in price levels as between 1909 and 1929.[3] The acreage of crops per farm increased about 6 percent, chiefly in corn and small grains, while the number of livestock units rose about one-sixth. Hog production expanded over two-thirds, while the cattle enterprise shifted toward dairy rather than beef production. From 1929 to 1935 the combined effects of drought, agricultural depression, and the corn-hog program of the Agricultural Adjustment Administration caused a contraction of the crop acreage per farm—chiefly in corn—to the figure of 1909, and a reduction of nearly a third in the output of hogs per farm.

Table 36.—*Employment, crop acreage, and livestock per farm, corn and dairy areas*

Item	Unit	Corn area		Eastern dairy area		Western dairy area	
		1909	1929	1909	1929	1909	1929
Persons employed per farm: [1]							
Total	Number	1.71	1.58	1.93	1.76	1.79	1.72
Family	do	1.27	1.12	1.26	1.14	1.38	1.24
Hired	do	.44	.46	.67	.61	.41	.48
Capital goods [2]	Dollars	[3] 2,226	3,940	[3] 2,023	4,154	[3] 1,952	4,176
Crop acres, total [3]	Acres	69.9	74.0	38.1	38.7	59.7	65.5
Corn	do	31.2	33.2	4.7	4.7	10.1	13.9
Small grain	do	21.6	25.2	8.7	8.1	27.1	26.3
Hay	do	14.5	13.4	19.4	20.9	17.8	20.2
Potatoes	do	.7	.3	1.4	1.2	1.7	1.4
Animal units, total	Number	14.4	16.4	15.0	13.6	13.7	17.8
Number head livestock [3]	do						
Cows milked	do	3.7	4.6	5.5	6.3	5.3	7.7
Other cattle	do	7.2	6.4	3.1	3.7	5.7	5.9
Stock sheep	do	5.9	4.9	2.9	2.4	5.5	4.0
Chickens	do	79	122	52	94	55	82
Horses and mules	do	5.5	3.9	2.8	2.1	3.9	3.3
Hog production [4]	Pounds	4,358	7,526	836	657	1,919	3,299

[1] Derived from WPA N. R. P. Report No. A-8, *Trends of Employment in Agriculture 1909–36*, tables 4, 7, 10, and Appendix B.

[2] Includes buildings, machinery, and livestock. Figures given are for 1910 and 1930 instead of 1909 and 1929, from table B-2 (filed in Bureau of Agriculture Economics Library).

[3] Acreages or number of livestock per farm from WPA N. R. P. Report No. A-6, *Trends in Size and Production of the Aggregate Farm Enterprise, 1909–36*, Appendix A, divided by number of farms from Report No. A-8, *Trends in Employment in Agriculture*, Appendix B.

Animal units for the purpose of this table were estimated on the basis of numbers of animals requiring 100 hours of labor per year; 1 animal unit equalling: 0.7 milk cow, 4.0 head of cattle other than milk cows, 2,500 pounds live weight of live hogs produced, 20 sheep, 50 chickens, 1.5 horses or mules.

[4] Pounds live weight.

[2] These were obtained by dividing the acreages of crops and numbers of livestock from WPA N. R. P. Report No. A-6, *Trends in Size and Production of the Aggregate Farm Enterprise*, Appendix A, by numbers of farms for the years indicated from WPA N. R. P. Report No. A-8, *Trends in Agricultural Employment, 1909–36*, Appendix B. Numbers of persons employed per farm were obtained from WPA N. R. P. Report No. A-6, by dividing total numbers of persons employed in agriculture for the respective areas by the same number of farms as above.

[3] This adjustment for price changes is only approximate. It was made by dividing the values at current rates for each period by the Bureau of Labor Statistics Index of Wholesale prices.

Despite rather pronounced changes in the relative importance of different farm enterprises and some increase in acreage, the corn area farm in 1929 differed less from that of 1909 than from the average farm of other areas. The key to the difference between the corn and dairy areas is found in the importance of corn among the crops and of hogs among the livestock enterprises.

Shifts in enterprises help explain the increase in size of farm and amount of produce per worker. The heaviest labor requirements on crops occur from May to July, and from September to November. In the livestock enterprises labor requirements are more evenly distributed over the year, but milk cows require more attention in the winter and early spring than during the crop-growing season when they are running on pasture. Hogs have heavier requirements in the winter months and in the spring and fall when sows are farrowing. Thus the diversification of enterprises in the corn area has provided a means of utilizing labor more fully throughout the year.

The reduction in labor needs on specific crops has permitted a reduction in amount of labor employed. An earlier report [4] showed that the average amount of labor used per acre of corn in the corn area declined 4.1 hours, or 19 percent from 1909–11 to 1927–31. At the same time the labor requirements in the production of oats declined 2.8 hours per acre, or 28 percent.[5] Even with some increase in acreage per farm, farmers could employ fewer workers and still expand the livestock enterprises.

Changes in the Dairy Areas

The dairy areas were characterized by the greater importance of hay among crops and of milk cows among livestock. Since 1909 there has been an increase of 10 percent in total crop acres in the western but only a small change in the eastern dairy area. Acreage of hay per farm increased in each area, and in the western area acreage of corn increased. In each of the dairy areas small-grain and potato acreages decreased.

Changes since 1909 have been more pronounced among livestock enterprises than in crops. Such changes varied between the two dairy areas. In each area, there was a decline in the average number of horses per farm. This decline released feed, stable room, and labor for taking care of more milk cows whose numbers increased about 15 percent per farm in the eastern and 45 percent in the western area. In each area, the number of chickens per farm increased greatly and the number of sheep declined. An important difference in trend occurred in pork production. In the eastern area, where hogs were already relatively unimportant, hog production per farm declined one-fifth. In the western area, however, acreage of feed crops expanded and pork production per farm increased by more than 70 percent.

Changes in labor per farm in the dairy areas were similar to those in the corn area, with small declines occurring chiefly in family workers. In the western dairy area, however, the equivalent of about one additional month of hired labor was employed per farm. The valuation of capital goods doubled, when valued at current prices, or rose a

[4] WPA N. R. P. Report No. A–5, p. 120.
[5] WPA N. R. P. Report No. A–10, p. 98.

half when corrected for changes in price levels. A large part of the rise is explained by expansion of the dairy enterprise, which requires a relatively large investment both in buildings and in cattle.

Developments in Southern Areas

In the South the average farm is much smaller than in any of the areas discussed so far. Crop acreages average 25 to 30 acres per farm except in the western cotton area (table 37), but include intensive crops such as cotton or tobacco. Livestock, particularly in the southeastern areas, is of relatively small importance, averaging 4 to 6 units per farm as compared to 15 or 16 units in the corn and dairy areas. Capital goods involve smaller investments than are needed farther north. The number of workers per farm, however, is larger in the South, and the difference is chiefly in the number of family workers. From 1909 to 1929 the average number of all workers per farm declined by 9 percent to 15 percent in each of the southern areas. Further slight declines occurred between 1929 and 1935, but in the earlier years the decline was in family workers, while in the more recent period it was in hired workers.

Table 37.—*Employment, crop acreage, and livestock per farm, southern areas, 1909 and 1929*

Item	Unit	Middle eastern area		Eastern cotton area		Delta cotton area		Western cotton area	
		1909	1929	1909	1929	1909	1929	1909	1929
Persons employed per farm:[1]									
Total	Number	2.03	1.73	2.45	2.12	2.29	1.99	2.07	1.89
Family	do	1.62	1.35	2.00	1.64	1.86	1.67	1.67	1.41
Hired	do	.41	.38	.45	.48	.43	.32	.40	.48
Capital goods[2]	Dollars	725	1,128	445	617	510	596	1,110	1,630
Crops[3]	Acres	26.3	24.0	31.0	31.3	25.4	24.9	51.9	68.1
Corn	do	11.9	9.6	10.6	11.2	10.1	7.2	18.8	10.8
Small grain	do	4.4	3.0	1.6	1.3	.6	.2	4.3	14.9
Hay	do	4.3	5.0	1.1	1.9	1.3	1.6	2.8	2.4
Cotton	do	1.9	2.6	14.4	13.4	10.2	13.4	20.1	31.0
Grain sorghums	do	------	------	------	------	------	(4)	3.1	6.9
Potatoes	do	.3	.3	(4)	.1	.1	.1	.1	.1
Sweetpotatoes	do	.2	.2	.3	.3	.2	.2	.1	.1
Tobacco	do	1.0	1.5	(4)	.3	(4)	(4)	------	------
Cowpeas and soybeans	do	.9	.3	1.7	.4	.7	.4	.7	.2
Peanuts	do	.3	.4	.7	1.5	.1	.1	.2	.5
Total animal units	Number	5.4	5.8	3.5	4.0	4.9	4.6	11.2	10.7
Number head livestock:[3]									
Cows milked	do	1.5	1.8	1.0	1.2	1.4	1.4	2.1	2.5
Other cattle	do	2.5	2.0	2.0	1.7	2.9	2.3	13.1	9.6
Stock sheep	do	2.6	2.4	.5	.2	.8	.6	3.8	9.0
Chickens	do	29	49	17	29	22	30	34	61
Horses and mules	do	2.3	1.9	1.5	1.5	2.2	1.8	5.4	4.0
Hog production[5]	Pounds	999	891	668	665	723	472	1,139	919

[1] Derived from WPA N. R. P. Report No. A-8, *Trends of Employment in Agriculture, 1909–36*, tables 9, 11, 13, 15, and Appendix B.

[2] Includes buildings, machinery and livestock, figures given are for 1910 and 1930 instead of 1909, 1929.

[3] Acreages or number of livestock per farm from WPA N. R. P. Report No. A-6, *Trends in Size and Production of the Aggregate Farm Enterprise, 1909–36*, Appendix A, divided by number of farms from WPA N. R. P. Report No. A-8, *Trends in Employment in Agriculture*, Appendix B. Animal units for the purpose of this table were estimated on the basis of numbers of animals requiring 100 hours of labor per year; 1 animal unit equalling: 0.7 milk cow, 4.0 head of cattle other than milk cows, 2,500 lbs, live weight of live hogs produced, 20 sheep, 50 chickens, 1.5 horses or mules.

[4] Under 0.05.

[5] Pounds live weight.

Changes in investment in capital goods since 1909 have been smaller in the southern areas than in any others. After corrections are made for differences in price levels, there is an increase in capital goods per farm of only 5 percent or 10 percent in the middle eastern and the western cotton areas, while in the eastern and the delta cotton areas there were declines.

In the eastern cotton area crop acreage per farm was practically unchanged, but cotton declined slightly, largely because of the boll weevil, and corn increased. Units of livestock increased from 3.5 to 4.0 per farm, but were still lowest of any major area. A moderate degree of diversification had occurred in some sections.

The delta cotton area was developing during this period. The increase in good cotton land along the Mississippi and its tributaries brought an expansion of over 3 acres of cotton per farm, or 30 percent. Corn declined by about an equal acreage.

The western cotton area expanded to an even greater degree. Average acres of crops per farm were increased by the addition of large farms in the western sections. The average acreage of cotton rose from 20 to 31. A shift from corn to grain sorghums took place and a sharp rise in wheat in the semiarid sections was noted. Among livestock, cattle and hogs declined per farm, but sheep and poultry increased. The great diversity in type of farm between the eastern and western parts of this area results in misleading averages per farm. For example, the increase in sheep occurred in the southwestern part of the area; the changes affecting small grains and grain sorghums were in the northwestern section; but increases in cotton occurred over the greater part of the region.

Expansion and Changed Organization in Western Regions

Two of the western regions, the small-grain and the range areas, saw a great expansion in crop acreages per farm, particularly in corn and small grain, between 1909 and 1929 (table 38). In the northwestern area, on the other hand, there was a small contraction particularly in small grain, as the number of farms increased faster than acreage in crops.

Numbers of milk cows, poultry, and hogs increased in each area, but other cattle declined somewhat. The number of workers per farm changed little, but valuation of capital goods in the three areas increased by 50 percent to 70 percent in current dollars and 10 percent to 20 percent when measured in constant dollars. The greater amount of equipment increased capacity per worker in crop production, while milk cows and poultry permitted fuller utilization of labor in slack seasons. The shift was toward the more intensive types of farms wherever topography and water supply permitted.

In each area a wide diversity in the size and type of farms is found. To some extent, each of these has followed a trend of its own. Consequently, changes in average figures may fail to give a very definite idea of what happened to the individual farm types.

TABLE 38.—*Employment, crop acreage, and livestock per farm, northwestern areas, 1909 and 1929*

Item	Unit	Small grain area		Range area		Northwestern area	
		1909	1929	1909	1929	1909	1929
Persons employed per farm: [1]							
Total	Number	1.69	1.63	2.00	2.11	1.80	1.73
Family	do	1.31	1.21	1.21	1.29	1.21	[2] 1.18
Hired	do	.38	.42	.79	.82	.59	.55
Capital goods [3]	Dollars	2,676	4,490	2,519	4,106	1,894	3,029
Crops [4]	Acres	140.3	186.8	43.3	85.0	61.6	58.6
Corn	do	37.4	45.2	4.2	13.9	.6	.8
Small grain	do	64.2	103.0	10.3	27.3	37.0	34.4
Hay	do	31.8	30.0	23.2	28.3	19.1	18.9
Cotton	do			([5])	2.5		
Grain sorghums	do	1.7	2.0	1.4	3.7		
Potatoes	do	.7	.7	1.0	.9	1.0	1.0
Dry edible beans	do	([5])	.2	.2	4.0	([5])	.9
Flaxseed	do	3.5	5.0	([5])	.1		
Cowpeas and soybeans		([5])	([5])				
Total animal units	Number	18.1	21.5	25.5	23.8	14.4	13.9
Number head livestock: [4]							
Cows milked	do	3.5	5.2	2.3	3.7	3.0	4.0
Other cattle	do	16.1	15.5	38.1	30.8	10.2	7.8
Stock sheep	do	14.3	12.3	126.0	86.9	43.4	32.6
Chickens	do	69.6	109.1	25.0	69.9	40.0	85.9
Horses and mules		8.6	7.2	8.5	6.9	6.3	3.8
Hog production [6]	Pounds	3,135	6,586	708	1,364	1,048	1,092

[1] Derived from Eldon E. Shaw and John A. Hopkins, *Trends in Employment in Agriculture, 1909–36* (WPA N. R. P. Rept. No. A-8), November 1938, tables 17, 19, 21 and Appendix B.

[2] Based on correction of number of family workers as given in source cited.

[3] Includes buildings, machinery, and livestock; figures given are for 1910 and 1930 instead of 1909 and 1929.

[4] Acreages or number of livestock per farm from Raymond Bressler, Jr., and John A. Hopkins, *Trends in Size and Production of the Aggregate Farm Enterprise, 1909–36* (WPA N. R. P. Rept. No. A-6, Appendix A), divided by number of farms from Shaw and Hopkins, *op. cit.*, Appendix B. Animal units for the purpose of this table were estimated on the basis of numbers of animals requiring 100 hours of labor per year; 1 animal unit equaling: 0.7 milk cow, 4.0 head of cattle other than milk cows, 2,500 pounds live weight of hogs produced, 20 sheep, 50 chickens, 1.5 horses or mules.

[5] Under 0.05.

[6] Pounds live weight.

CHANGES IN ORGANIZATION ON A SELECTED GROUP OF FARMS

Data obtained in the National Research Project Survey of 1936 throw some additional light on changes in groups of farms which are more homogeneous than the array represented by census averages.[6] Changes in organization of the farms since 1909 may be divided into those which were made by men who had been farming throughout the period, and those made by the new generation of farmers. These do not differ so much in type as in degree. The younger men are more likely to change their methods and organization, while the older ones are likely to operate their farms pretty much the same from year to year.

[6] Figures from this survey depend on the memory of the farmers interviewed. It is probable that changes shown in farm organization according to these data understate rather than overstate the degree of change that actually occurred. Comparisons between these farms and comparisons of these data with information from other sources suggest that only a few of the farmers interviewed overstated the shifts they had made, but that some of them forgot to report changes that had occurred in some elements of the farm.

Changes With Advancing Age of Farmers

Until farmers reach late middle age, they tend to acquire use or ownership of somewhat larger acreages of land. More family labor is available and farmers tend to employ fewer hired workers as the family grows. Later in life there tends to be some decline in acres per farmer. This is a cycle through which each individual is likely to pass.

In any given year, however, younger farmers tended to handle more acres of crops than older ones. This apparent inconsistency is explained by the fact that younger farmers are more likely to adopt improved methods, and therefore start off at a higher level of labor efficiency than did their fathers. For the year 1929, for which a special analysis was made of this relationship, statistically significant differences in crop acreages per man were found between age groups in the corn and the western dairy areas. In the eastern dairy and the small-grain areas, however, the differences were not large enough to be statistically significant. In dairy areas the number of units of livestock is likely to be more important than the acres of crops per man, and this was found to differ between age groups.

It was in the corn and small-grain areas that tractors offered the greatest advantages. In these areas a larger proportion of younger than of older men had, and were making greater use of tractors. The tendency of the younger men to adopt improvements more rapidly and more completely than older farmers is important, not only in interpreting the past, but in anticipating probable future developments. New methods or machines recently introduced are likely to continue to be adopted until the older generation of farmers is replaced by younger men. This observation may also furnish a general principle regarding the length of time required to complete such technological changes; that is, the shift to a new method may not be completed until the generation of farmers who were established before the change have all, or nearly all, disappeared.

During the farming life of the older groups of men studied, family labor per year (including the operator) increased 4 or 5 months as the farmers advanced from an average age of about 30 to an age of slightly over 50. In the meantime, hired labor, after increasing slightly during the first part of the farmer's business career, declined 2 or 3 months as his sons became large enough to help with the work.

Changes in Farm Organization Not Related to Age of Operator

Changes in varieties of crops and in type and grade of livestock appeared to be independent both of advancing age of the farmer and of adoption of mechanical power. One shift which can be seen clearly is that toward the production of alfalfa rather than the lower-yielding and less desirable mixed-hay crops of earlier years. In all four areas the acreage of alfalfa per farm more than doubled on the farms studied. Both the shift to alfalfa and the improvement in feeding methods have affected the number of livestock units handled per man and per 100 acres of crops.

Changes in Crops and Livestock in Corn Area

The net effect of the changes in farm organization as this effect is related to labor is summarized in the changes in crop acres and in livestock units per man. It was explained earlier that the effectiveness of labor on farms has been affected by the amount and form of capital per farm and per man, particularly by the adoption of mechanical power units. In any specific groups of farms, however, the effect of this adoption is likely to be obscured by the changing age of the farmers, by relative crop acreages, and other such factors. In the corn area the average crop acreage handled per man declined from 1909 to 1929, both in the tractor and the nontractor groups. From 1929 to 1936, however, this acreage increased, as the more effective row-crop type of tractor came into use and as the depression forced maximum performance per worker.

Many of the older farmers who bought tractors never made the fullest possible use of them. For one thing the older men bought early-type tractors while a larger proportion of the younger farmers had the more effective row-crop type. The younger men were handling more acres of crops per man-year of labor for the first period for which they reported than were ever handled by the older men. It seems likely that the younger men adopted more effective methods, otherwise, in addition to obtaining better equipment.

Western Dairy Area

In the western dairy area some of the more pronounced shifts in organization appear in the livestock enterprises. The total number of livestock units reported per farm by the older farmers for 1909 was about 31. The middle-aged and the younger farmers reported 35 to 43 animal units per farm in 1919 and 1929 respectively, when they were at corresponding stages of their farming life. Tractor farms have generally shown larger increases in the number of units of livestock than have the nontractor farms. Labor which was saved on crops by the use of tractors was evidently used for the care of more livestock. Most of the change in livestock occurred in the dairy enterprise although hogs increased also. Thus a saving of labor like that resulting from tractor adoption does not necessarily result either in a reduction of employment or in a larger crop acreage per worker. It may be used instead to expand the enterprise which is at the greatest relative advantage in the area.

The number of crop acres handled by the average worker in the western dairy area was only about half that of the corn area, and in 1929 averaged 37 or 38 acres in the group of oldest farmers, about 40 among the middle-aged group, and 54 among the youngest group. In 1909 these figures were 40 acres among those of the oldest group who later adopted tractors and 42 among those who did not. The younger farmers in 1929 handled only about 10 percent more crop acreage than did the young farmers in 1909, but the corresponding number of livestock had increased more than 30 percent.

Eastern Dairy Area

Farms are smaller in the eastern dairy area than in the western as is the acreage of land in cultivated crops on each farm. Eastern

farms had much less corn, small grain, and alfalfa per farm, but had more hay of other types. Numbers of livestock were less both per farm and per 100 acres of total land in the farms surveyed. The relative size of farm enterprises had changed very little in this area, and the adoption of a small acreage of alfalfa in place of other hay was the outstanding change in crops. In livestock enterprises, the total number of animal units on farms of the older and the middle-aged farmers increased around 10 percent, the increase occurring chiefly in milk cows and poultry. Briefly, changes in organization were small in this area, although such changes as occurred were in the same direction as those of the western dairy area.

Small-Grain Area

Among tractor farms in the small-grain area, the acreage of crops per farm increased rapidly during the period studied. A rather pronounced increase also occurred in the number of livestock, though this change was more noticeable in the non-tractor groups. In other words, the agriculture of the area was in process of intensification. This was true even though the younger farmers with up-to-date machinery could handle more acres of crops per man in 1929 than the older farmers did at corresponding ages in 1909. The most pronounced increase in crops occurred in the small grains, although acreages of tilled crops, corn, or grain sorghums, also increased within most of the age groups. On tractor farms emphasis was shifted from the production of livestock, mostly on pasture, to extensive production of crops. Crop acres per man almost doubled both within the group of older farmers and also as between the older farmers in 1909 and the younger ones in 1929.

The numbers of livestock per farm increased in each age group, but the younger tractor farmers in 1929 had fewer animal units than the older men had at the corresponding period in 1909. In the non-tractor groups, however, numbers of livestock increased within each age group and also from the older to the younger farmers. Thus, the relatively small number of men who did not obtain tractors usually concentrated their attention on more intensive production of livestock rather than on the production of greater acreages of crops. The largest increases in livestock occurred in milk cows, although there were increases in other cattle and in laying hens.

GENERAL TRENDS IN FARM ORGANIZATION

Changes in farm organization have been more limited in number and in extent than those in technology, and their usual effect has been to permit a more complete utilization of resources already on the farm. The trend toward diversification, which has occurred in several areas has generally resulted in greater production per worker. Diversification and widespread increases in number of milk cows and poultry have led to fuller utilization of labor throughout the season and also have tended to increase the production per acre of land. However, changes in organization have seldom led to an actual reduction in number of persons employed per farm or to consolidation of farms into fewer units.

Technological changes, on the other hand, have clearly led to reduction in numbers of persons employed. Furthermore, the development of larger equipment may stimulate the consolidation of farms and a still further displacement of labor. It is primarily the technological developments, such as the substitution of gasoline-consuming mechanical power for crop-consuming animal power that has shifted labor from farms to the city. Such influences are not clear-cut and distinct because some shifts of function from farm to city, like changes in the marketing system, may rest on economic influences and may be largely independent of technology, while others, which originate in technological discoveries, bring about incidental changes in the organization of the farm.

CHAPTER VIII. CHANGES IN LABOR REQUIREMENTS ON PRINCIPAL CROP AND LIVESTOCK ENTERPRISES

INFLUENCES AFFECTING LABOR ON CROPS

The average hours per acre on the crops to be considered in this chapter have been reduced, but the amount has varied considerably between areas, and unequivocal generalizations cannot be made. The reduction has been greatest for crops in areas of specialized production. On farms having relatively large acreages of certain crops, particular thought is commonly given to the development of labor-saving methods. On the other hand, improvement of methods on minor crops may be more or less neglected because the farm operator is giving most of his attention to the major enterprises.

On farms with the larger acreages, it is economically feasible to buy both larger and more specialized machinery, such as multi-row planters or cultivators, small-grain combines, or mechanical corn pickers. Such equipment can seldom be used where acreages are small. There may, however, be an opportunity on such farms for saving labor by the use of bigger implements, like plows, disks, and harrows, adapted to several crops. This depends on the total crop acreage rather than on acreage of the individual crop.

Among nonmechanical influences on hours per acre, one of the most important has been the shifting of acreage from areas where labor requirements are high to areas where they are low. This shift of acreage may also bring changes in yields that affect the labor per unit of product. Yields are influenced further by changes in varieties, amounts of fertilizer applied, and outbreaks of disease or insects.

In the following pages the amount of change in labor requirements for four major crops and for potatoes and selected truck crops will be examined briefly. For more detailed explanation the reader is referred to the reports on the individual crops.[1]

LABOR REQUIREMENTS IN CORN PRODUCTION

Corn, our most widely grown major crop, illustrates the difficulty of generalizing about the trends in labor used per acre or per bushel because it is grown under varying conditions of climate, soil, topography, and type of farm, and is harvested for grain, fodder, and silage. Methods that differ widely between areas and between farms are used, both in growing the crop and in harvesting it.

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[1] See reports on *Changes in Technology and Labor Requirements in Crop Production* as follows: WPA N. R. P. Reports Nos. A–4, *Potatoes;* A–5, *Corn;* A–10, *Wheat and Oats;* A–7, *Cotton;* A–12, *Vegetable Crops.*

In general, more labor was required per acre, on farms surveyed, when the corn was harvested by cutting and shocking and later husking from the shock than when picked from the stalk for grain. The former practice was followed most commonly in eastern sections, where small acreages of corn were grown and where the stover was carefully conserved for forage. Least labor was used where the crop was harvested for fodder and the ears were fed with the stalk. This latter practice was followed most often in the small-grain area, where yields are light. The greater part of the crop, however, was harvested for grain by husking from the standing stalk, the practice commonly followed in the corn area and the cotton area. Where the corn was husked from the stalks labor varied from approximately 6 hours an acre in the southern small-grain area to more than 33 in the delta cotton area. As between sections of the corn area, however, even when the corn was all harvested by this same method, labor varied from 11 to 17 hours.

Some of the difference in labor was caused by the variation in yield as between sections, but this applies chiefly to harvesting. Labor before harvest is strongly affected by the methods used and by size and type of equipment. It is quite generally lower with tractor than with horsepower, since the tractor generally means larger implements, drawn at a greater speed. Where the farmers use horses for all operations in producing the crop, the hours in 1936 were nearly as high as they were in the earlier years studied (table 39). The more operations performed by tractors, the lower the labor requirements per acre.

TABLE 39.—*Labor used in producing corn according to extent of tractor use*[1]

Year and operations	Horses used only	Tractors used for		
		Seedbed preparation	Seedbed preparation and cultivation	Seedbed preparation, cultivation, and harvest
Total:	*Hours*	*Hours*	*Hours*	*Hours*
1909	15.6			
1919	14.9	13.0		
1929	14.4	12.5	10.7	9.0
1936	14.6	12.7	10.1	6.7
Preharvest:				
1909	10.0			
1919	9.4	7.4		
1929	8.9	7.1	5.0	5.6
1936	9.0	7.2	4.8	4.1
Harvest:				
1909	5.6			
1919	5.5	5.6		
1929	5.5	5.4	5.7	3.4
1936	5.6	5.5	5.3	2.6

[1] Loring K. Macy, Lloyd E. Arnold, and Eugene G. McKibben, *Changes in Technology and Labor Requirements in Crop Production: Corn* (WPA N. R. P. Report No. A-5, table 43, p. 117).

TRENDS IN LABOR REQUIREMENTS SINCE 1909

Since 1909 average hours required for an acre of corn have declined from 28.7 to 22.5, or 22 percent. The relative drop has been rather uniform in the corn, small-grain, dairy, and western cotton areas, but in the middle eastern, eastern cotton, and delta cotton areas the reduction was only 8 percent to 12 percent. In the eastern dairy area a good part of the saving is to be attributed to a shift from cutting and shock-

ing corn to harvesting for silage, while in other areas it has been largely a result of mechanization. This, however, is not by any means the only reason. About one-fifth of the decline in hours for the coun-

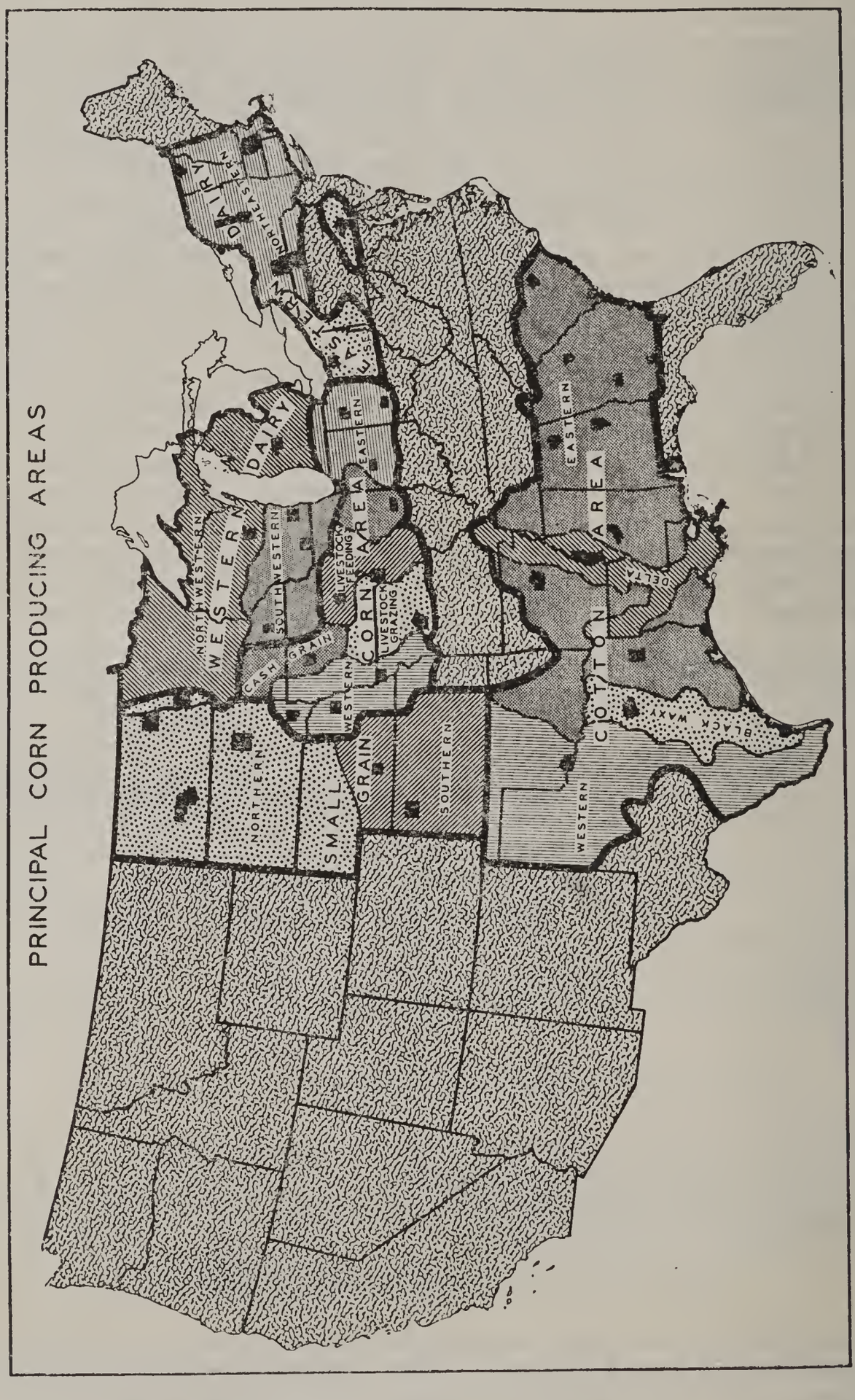

FIGURE 19.—Principal corn producing areas.

try is accounted for by shifts in the corn acreage from the high-labor areas to low-labor areas. Thus, acreage of corn increased in the small-grain areas and in the western dairy area, where hours per acre on

corn are relatively low, and declined in the eastern and southeastern States, where hours are high. From this cause there was a decline of about 4 percent of the 1909 average for the country as a whole [fig. 19].

When the labor used in growing the crop is expressed per 100 bushels of corn raised, it is found to have fallen 17 percent as compared to a 22 percent decline per acre. Figures 20 and 21 show that

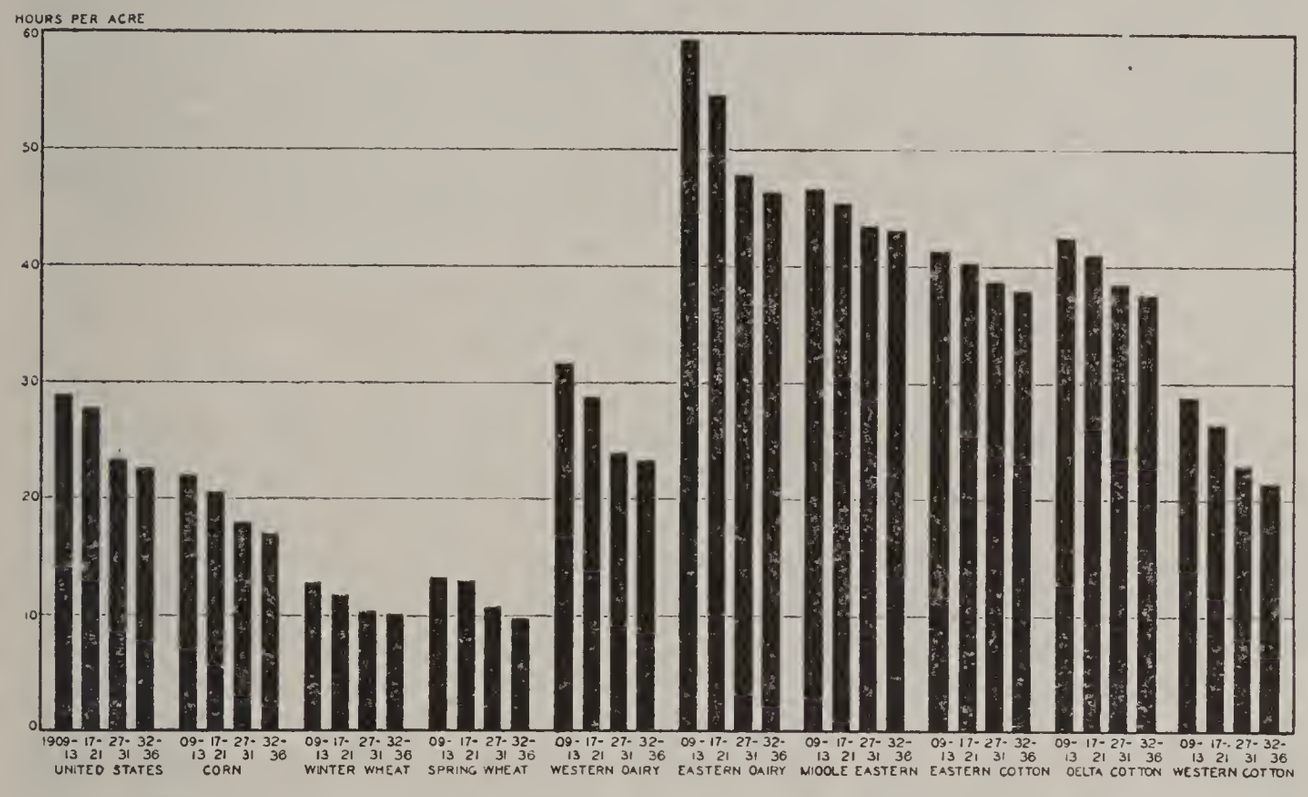

FIGURE 20.—Variations in labor used per acre in producing corn, by areas for specified periods, 1909–36.

Source: *Changes in Technology and Labor Requirements in Crop Production, Corn,* WPA N. R. P. Report No. A–5, table 44.

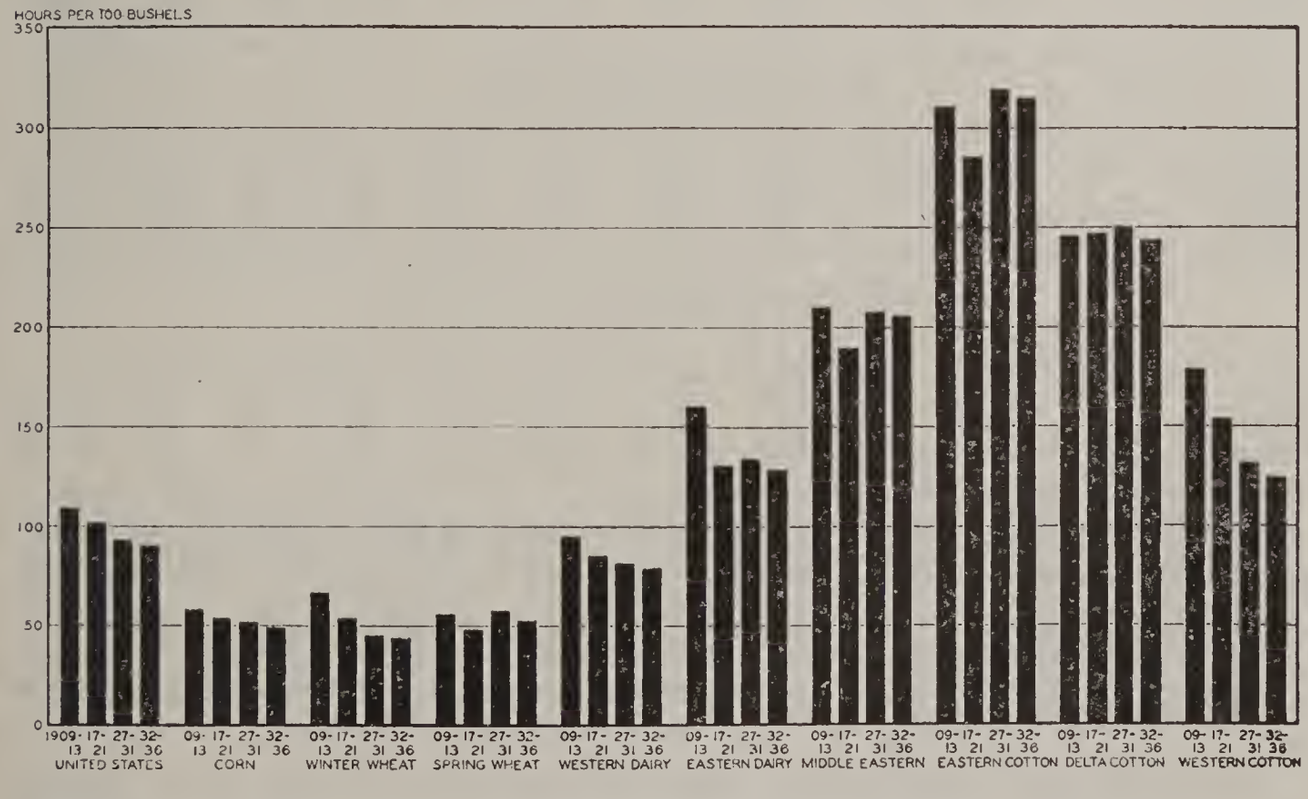

FIGURE 21.—Variations in labor used in producing 100 bushels of corn, by areas, for specified periods, 1909–36.

Source: *Changes in Technology and Labor Requirements in Crop Production, Corn,* WPA N. R. P. Report No. A–5, table 44.

the reduction in hours per 100 bushels is less striking in most areas than when expressed per acre. Most of the difference is attributable to a somewhat smaller yield in the more recent period.

Total amount of labor used annually in raising corn was 544 million man-hours less in 1927–31 than in 1909–13, as shown in table 40, and there was a further decline of 78 million hours by 1932–36. The combined reduction is equivalent to about 200,000 man-years of farm employment, when counted at 3,000 hours per year. The number of persons affected was undoubtedly greater than this because the saving in labor occurred in the peak seasons of the farm-labor year. The loss of employment fell most heavily on hired laborers who are employed only part of the year, during the crop-growing season.

TABLE 40.—*Total labor used in producing corn*

Period	United States	Corn area	Winter wheat area	Spring wheat area	Western dairy area	Eastern dairy area	Middle eastern area	Eastern cotton area	Delta cotton area	Western cotton area
ACRES IN CORN[1] (MILLIONS)										
1909–13	101.0	28.6	15.5	2.8	5.7	2.4	12.3	7.8	6.3	10.3
1917–21	103.1	28.8	13.4	4.3	7.2	2.5	12.6	9.6	6.9	8.1
1927–31	101.0	28.4	16.2	6.1	7.8	2.0	10.3	7.9	5.2	7.8
YIELD PER ACRE[1] (BUSHELS)										
1909–13	26.0	38.2	19.2	23.5	33.8	36.8	22.1	13.4	17.3	16.0
1917–21	27.2	38.5	21.8	27.0	33.6	41.7	24.0	14.0	16.7	17.1
1927–31	24.7	34.9	22.5	18.4	29.8	36.0	21.0	12.0	15.3	17.1
HOURS PER ACRE[2]										
1909–13	28.7	22.0	12.8	13.4	31.7	59.4	46.6	41.3	42.5	28.8
1917–21	27.6	20.6	11.8	13.0	28.7	54.6	45.3	40.2	41.1	26.4
1927–31	23.3	17.9	10.3	10.7	24.0	47.8	43.3	38.6	38.5	22.8
1932–36[3]	22.5	16.9	10.1	9.8	23.2	46.2	43.0	37.9	37.6	21.4
HOURS PER 100 BUSHELS										
1909–13	109	57	67	56	95	160	210	310	246	179
1917–21	102	54	54	48	86	131	190	285	247	153
1927–31	93	52	45	58	82	134	208	320	250	132
1932–36[4]	90	49	44	53	79	129	206	315	244	124
TOTAL LABOR (MILLIONS OF HOURS)										
1909–13	2,898	629	198	38	181	143	573	322	268	297
1917–21	2,842	593	158	56	207	136	571	386	284	214
1927–31	2,354	508	167	65	187	96	446	305	200	178
1932–36[3]	2,276	480	164	60	181	92	443	299	196	167

[1] 5-year average acreages and yields were computed from appendix A, N. R. P. Report No. A-5.

[2] Estimates based on former labor-requirement studies and the N. R. P. Farm Survey data. More detailed data for areas and for principal corn-growing States are shown in appendixes G and H, N. R. P. report No. A-5.

[3] Based on 1927–31 acreage, to eliminate as far as possible the effect of drought and AAA.

[4] Based on 1927–31 average yield, to eliminate effect of drought during the years 1932–36.

Source: Loring K. Macy, Lloyd E. Arnold, and Eugene G. McKibben, *Changes in Technology and Labor Requirements in Crop Production: Corn*, WPA N. R. P. Report No. A-5, table 44, p. 120.

Of the loss in employment between 1909–13 and 1927–31, slightly over one-fourth occurred in the corn area where the number of man-hours used in corn production fell about 20 percent. About the same proportionate reduction occurred in the middle eastern area and in

the delta cotton area, while in the eastern dairy and the western cotton areas declines since 1909–13 amounted to 33 percent and 40 percent respectively.

Probable Trends in Labor Requirements in Raising Corn

It is clear that the trends in hours required to produce an acre or 100 bushels of corn vary considerably between areas. In the corn area and the western dairy area large farms and gently rolling fields made for relatively rapid mechanization, but until recently this affected only the labor before harvest. With a few exceptions it was necessary to harvest the crop by hand. Thus, a man could raise more corn than he could harvest. Now, with the spread of the mechanical corn picker in much of this region, it is likely that mechanization will receive a fresh impetus and that labor requirements will fall further. In the small-grain area conditions are favorable to the use of large equipment, though yields are low. Labor requirements have already declined rapidly in most sections, but for this very reason it seems less likely that the future reduction will be as great as in the corn area.

In the eastern dairy and the middle eastern area corn is commonly grown in relatively small fields and on hilly land. Under these conditions farmers are not able to afford large equipment, and it seems likely that labor requirements here will remain relatively high. The barriers to labor saving in the cotton areas are even greater. Small farms, small, irregularly shaped fields, and low wages together have made for the use of relatively large amounts of labor per acre, even in spite of the low yields. On the few farms which have been able to shift to larger equipment in recent years some reduction in labor per acre has been made, but these farms make up a relatively small percentage of the total. The others are able to change only with great difficulty.

From these trends, it appears probable that there will be further substantial reductions in the labor spent on an acre or on 100 bushels of corn in the central and western areas, although most of the decline has probably taken place already in the small-grain areas. Elsewhere the trends are also downward but the physical and economic difficulty of shifting to the most efficient equipment makes slower progress seem likely in the East and South.

LABOR REQUIREMENTS IN WHEAT PRODUCTION

Wheat, like corn, is raised under a wide range of conditions. In the small-grain area it is the principal crop, and the organization and equipment of the farm are fitted to its needs. In eastern areas and in the South, wheat and oats are minor crops and the seedbed is prepared with whatever equipment is available for use on corn and other crops. Likewise, in the eastern dairy area straw is needed for bedding for dairy cattle and for other livestock and, therefore, methods of harvesting are used that will conserve the straw as well as the grain, while in the small-grain area straw has little or no value.

In 1936 labor used in growing and harvesting an acre of wheat in the small grain area varied between sections from 2.2 to 4.9 hours. Slightly more than half of the total was ordinarily used in preparing the seedbed and planting the crop, and the rest in harvesting.

In the corn area, where wheat is grown on farms of small acreage and with smaller equipment, the total labor amounted to nearly 9 hours an acre, nearly two-thirds of which was for harvesting. The highest labor requirements were found in the cotton area, where small patches of wheat are sometimes grown for poultry feed, and where much of the wheat is seeded and some is reaped by hand. Averages of 22.8 and 15.2 hours an acre were found in the two counties studied here. In Lancaster County, Pa., the bound grain is ordinarily stored in the barn before threshing, because of the humid climate and danger

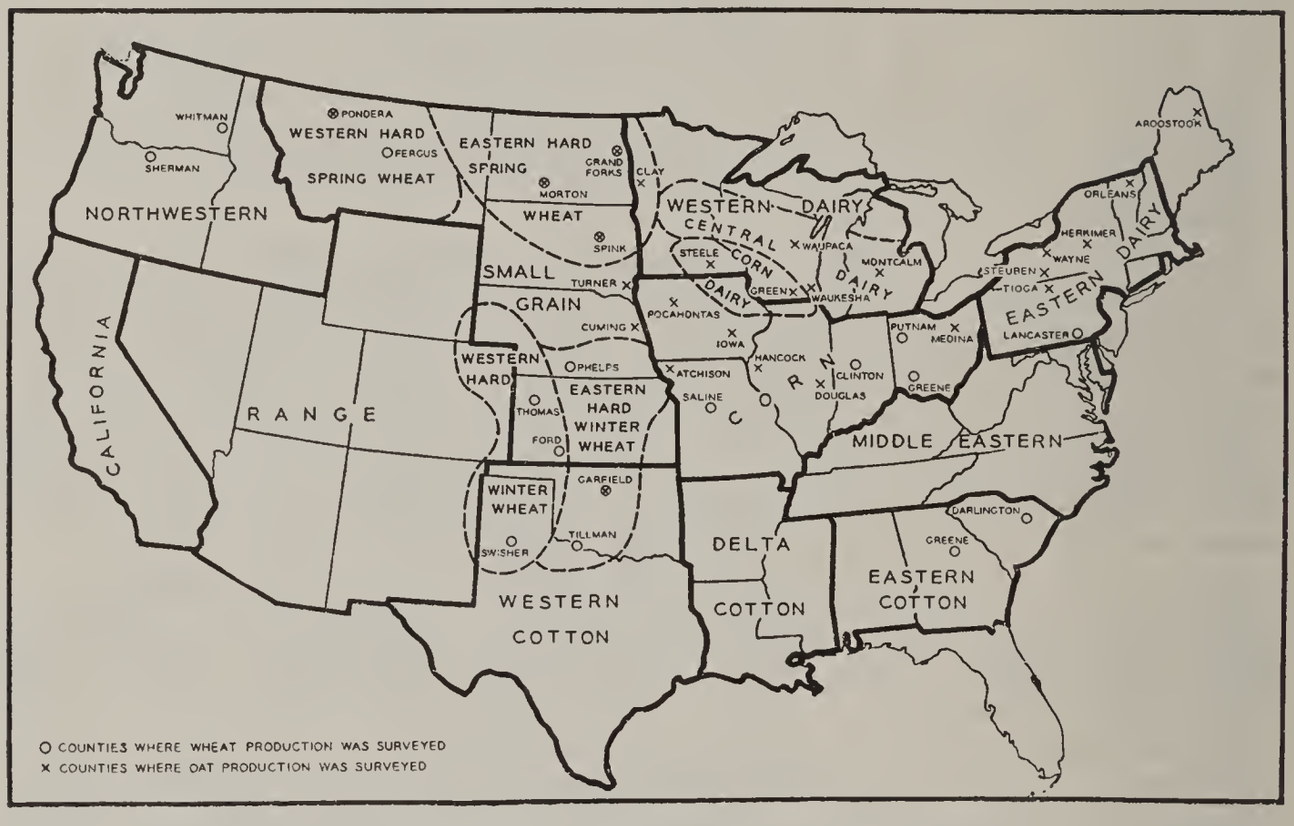

FIGURE 22.—Major type-of-farming areas of the United States and location of counties where grain production was studied.

of damage by rain. Here the total labor amounted to more than 18 hours an acre, two-thirds of which was spent in harvesting and threshing.

TRENDS IN LABOR REQUIREMENTS SINCE 1909

In 1927–31 (the latest period before the drought years) acreage in wheat in the United States was about a quarter greater than in 1909–13, the increase occurring almost entirely in the area west of the Missouri River, where labor requirements per acre are relatively low. This geographic shift has brought a reduction in the hours per acre in raising the crop of about 8 percent, even aside from effects of changing practices. The reduction from labor-saving practices, and particularly from the use of larger equipment, was much more than this.

On the large farms of the small-grain area, seedbed preparation has been made easier by the adoption of vertical disk plows, duckfoot field cultivators, and rotary-rod weeders, as well as by the general use of larger, tractor-drawn equipment. Labor per acre spent in preparing the seedbed and seeding has been reduced by 1 to 1.5 hours to the acre since 1909 on the farms studied. Harvesting labor has declined about twice as much as preharvest operations. This is largely because of the adoption of the combined harvester-thresher, which was used by very few farmers in 1909, but by 1936 was found on a half to three-quarters of the farms in the small-grain sections. The effects of these labor-saving methods on labor per acre and per bushel are shown in figure 23.

If we combine all areas, from the small-grain area to the West, we find that the labor per acre of wheat in the 1909–13 period averaged 10.0 hours. In 1934–36 it was only 4.2 hours, a decrease of 58 percent. East of the small-grain area, in contrast, the hours used on an acre fell only 23 percent. In eastern areas wheat acreages were not large enough for use of the combine and most of the decline occurred in operations prior to harvest, because larger plows, disks, and so on had been adopted for use on other crops.

Between 1909–13 and 1927–31 total labor used in growing wheat decreased 33 percent (table 41). A further reduction, equal to 7 percent of the pre-war requirements, occurred from 1927–31 to 1934–36 even after allowing, insofar as was possible, for effects of the Agricultural Adjustment Administration and the droughts of the 1930's.

Of the total reduction of 203 million man-hours in labor required for wheat production, between 1909–13 and 1927–31, about four-fifths occurred in the small-grain, corn, and western dairy areas. In the small-grain area, a decrease of 57 million man-hours, or 27 percent, occurred in spite of an expansion of 10 million acres. In the range area, where acreage tripled, the labor requirement rose only a quarter. A contrast was found in wheat acreage in the corn and western dairy areas, however, and the labor used on the crop fell by 62 and 40 million hours, respectively.

As with corn, the number of persons employed fell more than the reduction in hours would indicate, since the labor saving occurred during the peak season. This was particularly true in the small-grain area, where the army of seasonal workers, who formerly followed the grain harvest northward during the summer, was almost entirely displaced during the period we are studying.

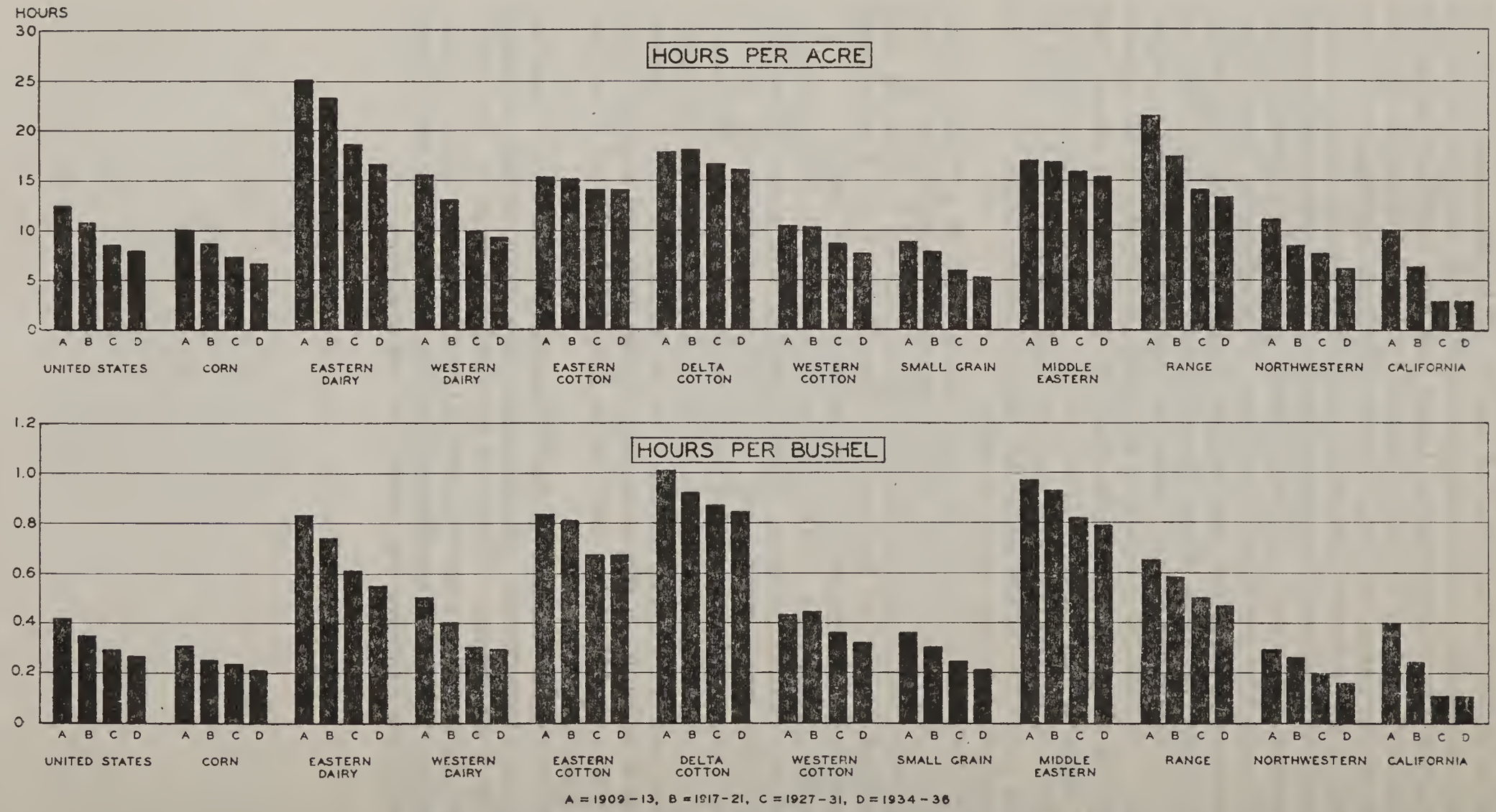

FIGURE 23.—Labor used in producing wheat, by areas, 1909–36.

Source: Based on data in table 24, *Changes in Technology and Labor Requirements in Crop Production: Wheat and Oats*, WPA N. R. P. Report No. A–10.

TABLE 41.—*Total labor on wheat*

ACRES HARVESTED [1]

Period	United States	Corn Area	Eastern dairy area	Western dairy area	Eastern cotton area	Delta cotton area	Western cotton area	Small grain area	Middle eastern area	Range area	North western area	California
	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 ares*	*1,000 acres*
1909–13	48,075	8,930	1,527	4,619	164	82	2,215	22,158	3,440	801	3,446	502
1917–21	61,696	11,600	1,759	4,320	240	151	5,450	27,439	3,540	1,972	4,281	717
1927–31	60,472	7,012	1,248	2,342	116	26	7,360	32,561	2,071	2,411	4,525	641

MAN-HOURS REQUIRED PER ACRE [2]

	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
1909–13	12.7	16.4	22.7	14.3	16.0	16.0	10.2	9.8	18.3	15.7	9.4	11.0
1917–21	10.3	14.1	21.5	12.4	16.3	16.1	8.4	7.3	18.1	10.3	8.2	8.0
1927–31	6.7	12.0	18.3	11.1	16.1	16.0	3.9	4.9	18.0	6.5	5.3	3.2
1934–36 [3]	6.1	11.7	17.2	10.6	16.1	15.0	3.3	4.2	17.1	6.3	4.4	3.2

MAN-HOURS REQUIRED ON TOTAL ACREAGE

	1,000 hours	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*
1909–13	608,526	146,452	34,663	66,052	2,624	1,312	22,593	217,148	62,952	12,576	32,392	5,522
1917–21	637,662	163,560	37,818	53,568	3,912	2,431	45,780	200,305	64,074	20,312	35,104	5,736
1927–31	405,662	84,144	22,838	25,996	1,868	416	28,704	159,549	37,278	15,672	23,982	2,051
1934–36 [3]	367,313	82,040	21,466	24,825	1,868	390	24,288	136,756	35,414	15,189	19,910	2,051

WHEAT PRODUCED [4]

	Mil. bu.	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*
1909–13	682.0	139.3	27.0	73.0	1.4	0.7	26.0	278.4	42.9	15.0	69.0	7.4
1917–21	828.0	185.0	30.0	62.0	1.9	1.4	69.0	312.6	42.2	32.0	77.0	10.8
1927–31	887.0	121.4	23.0	39.0	1.1	.3	92.0	435.8	30.6	34.0	95.0	11.4

MAN-HOURS REQUIRED PER BUSHEL

	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
1909–13	0.89	1.05	1.28	0.90	1.87	1.87	0.87	0.78	1.47	0.84	0.47	0.75
1917–21	.77	.88	1.26	.86	2.06	1.74	.66	.64	1.52	.63	.46	.53
1927–31	.46	.69	.99	.67	1.70	1.39	.31	.37	1.22	.46	.25	.18
1934–36 [3]	.41	.68	.93	.64	1.70	1.30	.26	.31	1.16	.45	.21	.18

[1] Based on table C–1, N. R. P. Report No. A–10.
[2] Based on table G–1, N. R. P. Report No. A–10.
[3] Based on 1927–31 acreage and production in order to eliminate the effects of the AAA program and drought.
[4] Based on table C–3, N. R. P. Report No. A–10.

Source: Robert B. Elwood and others, *Changes in Technology and Labor Requirements in Crop Production: Wheat and Oats*, WPA N. R. P. Report No. A–10, table 24, p. 95.

LABOR REQUIREMENTS IN THE PRODUCTION OF OATS

The hours used in growing an acre of oats are ordinarily higher in the eastern and lower in the western areas, as with wheat. In the small-grain area in 1936, however, an average of 5.9 hours was used an acre on oats and this was considerably higher than for wheat. The chief reason was that oats are less often harvested with the combine. Oat straw has considerable feeding value and the crop is more often cut with a binder so that the straw can be saved more easily.

In the corn area the oats are ordinarily seeded in corn stubble after the soil is prepared with a disk and the seeding is ordinarily done by means of broadcasting machines. In 1936 an average of 6.4 hours was used to an acre. Farther east and north, in the western dairy area, the land is generally plowed and a large part of the crop is seeded with drills, thus increasing the labor to a total of 10 or 15 hours for an acre.

In the eastern dairy area farms are smaller and the topography is more broken. The seedbed is more carefully prepared and labor requirements are further increased because the crop is often stacked or stored in the barn before it is threshed, necessitating an extra handling. In 1936 an acre required an average of 19.4 hours on the farms studied in 5 eastern counties. In some sections hours run considerably higher, while in others, where the land is moderately smooth and where more modern equipment is used, they compare favorably with western dairy sections.

Trends in Labor Requirements Since 1909

As oats are raised as one crop in a diversified cropping system farmers have but little specialized equipment for their production. Labor requirements have been reduced, partly by changes in practices and partly by the adoption of tractor power, or the use of larger teams on equipment used in general seedbed preparation. Although these influences have not operated uniformly over the country, total labor used in growing an acre of oats has fallen some 35 to 40 percent from 1909–13 to 1934–36 in the northern areas studied (fig. 24). In southern areas methods have changed only a little, and labor requirements in the more recent period have been only 8 percent or 10 percent below those in 1909–13. For the whole country the reduction averaged 37 percent.

From 1909–13 to 1927–31 labor on oats was reduced by 114 million man-hours, or 25 percent (table 42). By 1934–36, labor on oats further declined 28 million hours a year even allowing for the effects of the AAA programs and the droughts.

Trends in Labor Requirements in Small-Grain Production

What are the probabilities that labor requirements in the production of small grain will be reduced still further? In the western areas the requirements on wheat have already been reduced to about 4 hours an acre, and on oats only 5.3 hours were used in the small-grain area and 6.7 in the corn area on farms studied in 1936. Consequently, it might seem that there is little room for further reduction, at least in terms of absolute numbers of hours per acre. Many of the farmers have not yet obtained the largest or the most effective equipment available. This is more true in some sections than in others. For instance, in the eastern hard red spring wheat section only a small percentage of the farmers interviewed used combines in 1936. As the percentage using this machine increases, there will be a further decline in harvesting labor.

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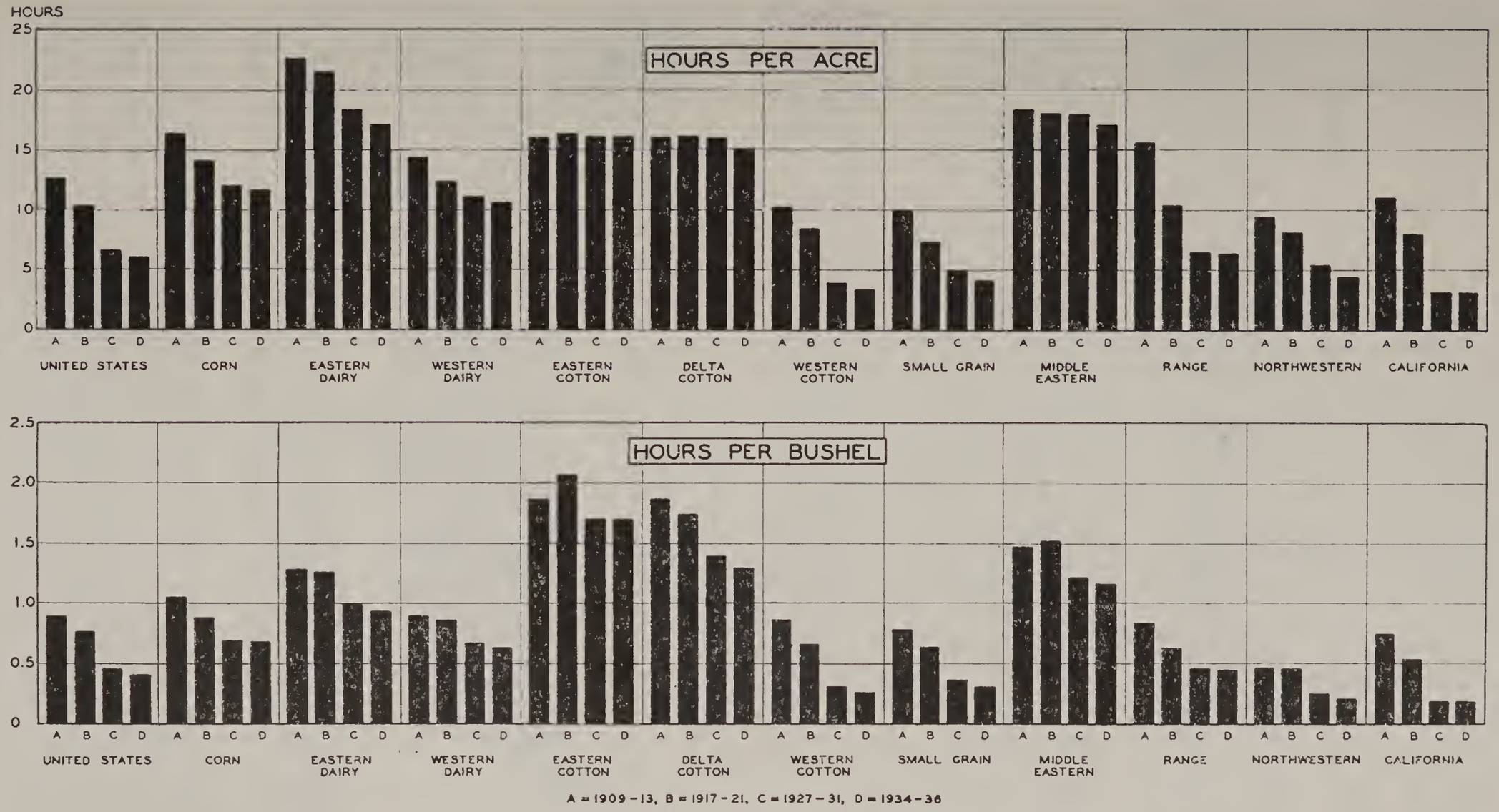


FIGURE 24.—Labor used in producing oats, by areas, 1909–36.

Source: Based on data in table 25, *Changes in Technology and Labor Requirements in Crop Production: Wheat and Oats*, WPA N. R. P. Report No. A–10.

TABLE 42.—*Total labor on oats*

ACRES HARVESTED [1]

Period	United States	Corn area	Eastern dairy area	Western dairy area	Eastern cotton area	Delta cotton area	Western cotton area	Small grain area	Middle eastern area	Range area	Northwestern area	California
	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*
1909–13	36,708	13,993	2,494	6,620	959	335	1,473	8,022	1,037	456	909	178
1917–21	42,388	15,763	2,355	7,703	838	402	3,143	9,697	1,028	435	676	136
1927–31	39,745	15,905	1,899	8,229	752	187	2,582	8,204	802	408	522	91

MAN-HOURS REQUIRED PER ACRE [2]

	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
1909–13	12.5	10.1	25.1	15.6	15.3	17.8	10.5	8.8	17.0	21.5	11.1	10.0
1917–21	10.8	8.7	23.3	13.1	15.2	18.1	10.3	7.8	16.8	17.4	8.5	6.3
1927–31	8.6	7.3	18.6	9.9	14.1	16.7	8.7	6.0	15.8	14.1	7.7	2.8
1934–36 [3]	7.9	6.7	16.7	9.3	14.1	16.1	7.7	5.3	15.3	13.3	6.2	2.8

MAN-HOURS REQUIRED ON TOTAL ACREAGE

	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*
1909–13	457,769	141,329	62,599	103,272	14,673	5,963	15,466	70,594	17,629	9,804	10,090	1,780
1917–21	456,392	137,138	54,872	100,909	12,738	7,276	32,373	75,637	17,270	7,569	5,746	857
1927–31	343,679	116,106	35,321	81,467	10,603	3,123	22,463	49,224	12,672	5,753	4,019	255
1934–36 [3]	315,513	106,564	31,713	76,530	10,603	3,011	19,881	43,481	12,271	5,426	3,236	255

OATS PRODUCED [4]

	Mil. bu.	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*
1909–13	1,079.6	454.7	75.2	208.0	17.6	5.9	36.2	198.8	18.2	15.0	34.4	4.5
1917–21	1,293.8	555.2	73.8	253.8	15.8	7.9	73.8	248.4	18.6	13.0	22.2	3.5
1927–31	1,183.6	506.9	57.6	268.2	15.8	3.6	62.2	206.0	15.5	11.6	19.8	2.3

MAN-HOURS REQUIRED PER BUSHEL

	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
1909–13	0.42	0.31	0.83	0.50	0.83	1.01	0.43	0.36	0.97	0.65	0.29	0.40
1917–21	.35	.25	.74	.40	.81	.92	.44	.30	.93	.58	.26	.24
1927–31	.29	.23	.61	.30	.67	.87	.36	.24	.82	.50	.20	.11
1934–36 [3]	.27	.21	.55	.29	.67	.84	.32	.21	.79	.47	.16	.11

[1] Based on table C–4, N. R. P. Report No. A–10.
[2] Based on table G–2, N. R. P. Report No. A–10.
[3] Based on 1927–31 acreage and production in order to eliminate the effects of the AAA program and drought.
[4] Based on table C–6, N. R. P. Report No. A–10.

Source: Robert B. Elwood and others, *Changes in Technology and Labor Requirements in Crop Production: Wheat and Oats*, WPA N. R. P. Report No. A–10, table 25, p. 98.

In eastern areas, where wheat and oats are minor crops in a diversified cropping system, labor spent in preparing the seedbed will probably decline about in proportion to that for the other crops. This depends largely on the rate at which tractors and larger teams of horses are adopted. In harvesting, the recent development of the small combine may well bring a reduction in labor requirements in

the corn area and in other regions as well. Of course, many of the smaller farms in eastern areas will probably not be able to utilize these machines but they have already appeared in some sections of the eastern dairy area as well as farther west, and are sure to have some effect.

LABOR REQUIREMENTS IN COTTON PRODUCTION

The cotton crop has two pronounced labor peaks when large amounts of hand labor are necessary, during the spring and early summer when cotton is chopped and hoed, and during the fall when it is picked. Both of these operations are difficult to mechanize, particularly the picking, and as a result there has been but little progress toward reduction of labor.

In 1936, operations before harvest required an average of 60 to 65 hours an acre on the farms studied in the Piedmont, Coastal Plains, eastern hilly, and Mississippi Delta sections. West of the Mississippi River labor requirements were lower, partly because of the use of larger equipment, partly because of climatic conditions which resulted in less weed growth than farther east, and partly because of lower yields which require less labor in picking.

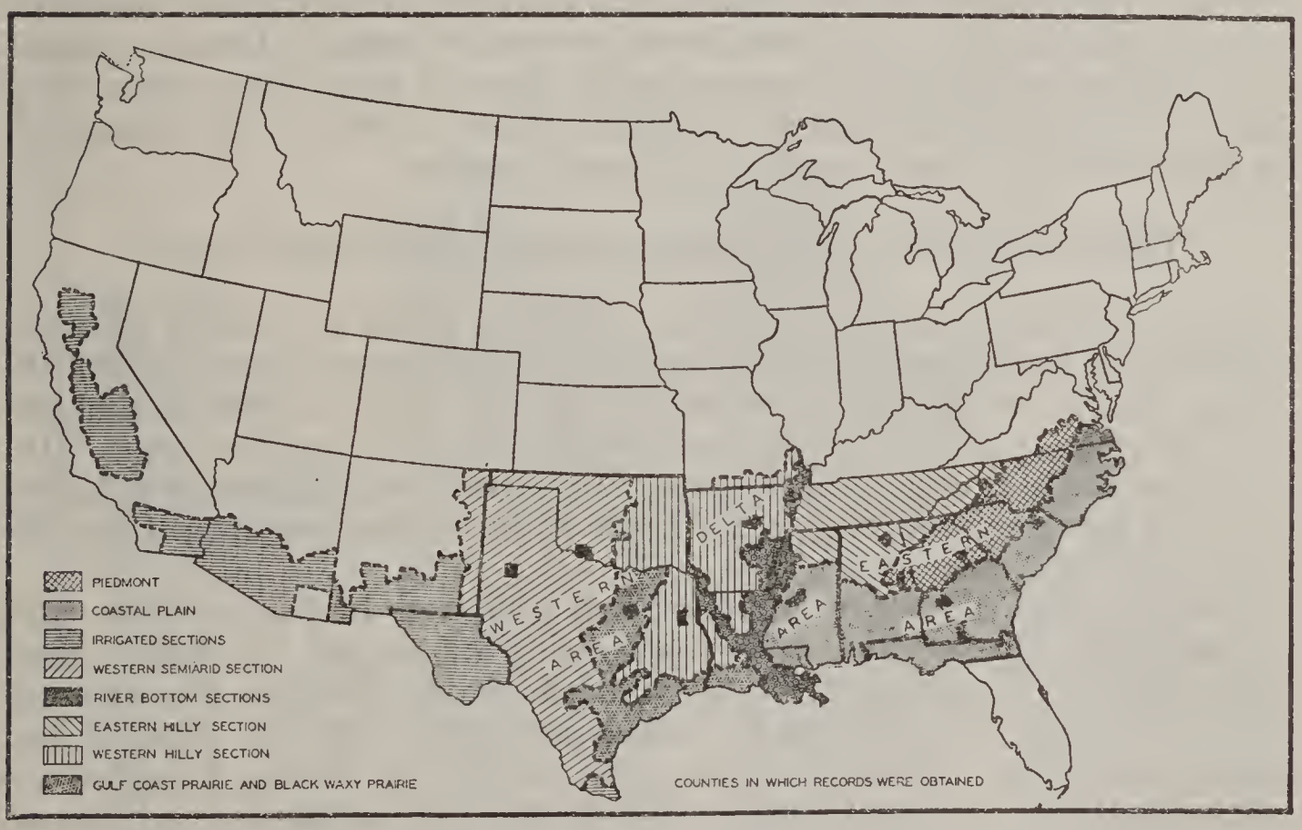


FIGURE 25.—Major cotton-producing areas of the United States.
Source: WPA National Research Project.

In the first three sections named, much one-mule equipment is used and, consequently, a large amount of labor is necessary in preparing the seedbed and cultivating the crop. In the hilly section west of the Mississippi River preharvest labor was about a fifth lower than farther east because of the use of more one-row, two-horse equipment. In the Mississippi Delta section climatic and soil conditions are favorable to a heavy growth of weeds. Therefore, much hoeing is necessary and this offsets the labor saving from larger machinery which is found on many large plantations here.

A comparison of the percentage of farms surveyed which had tractors in 1919, 1929, and 1936 shows for nine eastern counties 1, 2, and 3 percent; for the Mississippi Delta (Bolivar and Washington Counties) 5, 32, and 45 percent; and for three western counties (Texas black waxy and western semiarid sections) 5, 17, and 41 percent respectively.

The process of mechanization is already well started in the delta as well as in the Texas black waxy prairie, but it has not yet been possible to accomplish any appreciable reduction in the labor spent on hoeing and picking.

In the Texas black waxy section in 1936, preharvest labor was only about 40 percent as great as farther east. Tractor and larger sized horse-drawn equipment is not uncommon and only about half as much labor is needed in hoeing and chopping as in the eastern sections. Also, yields are lower and less harvest labor is needed. Consequently the total labor per acre amounted to only 48 hours.

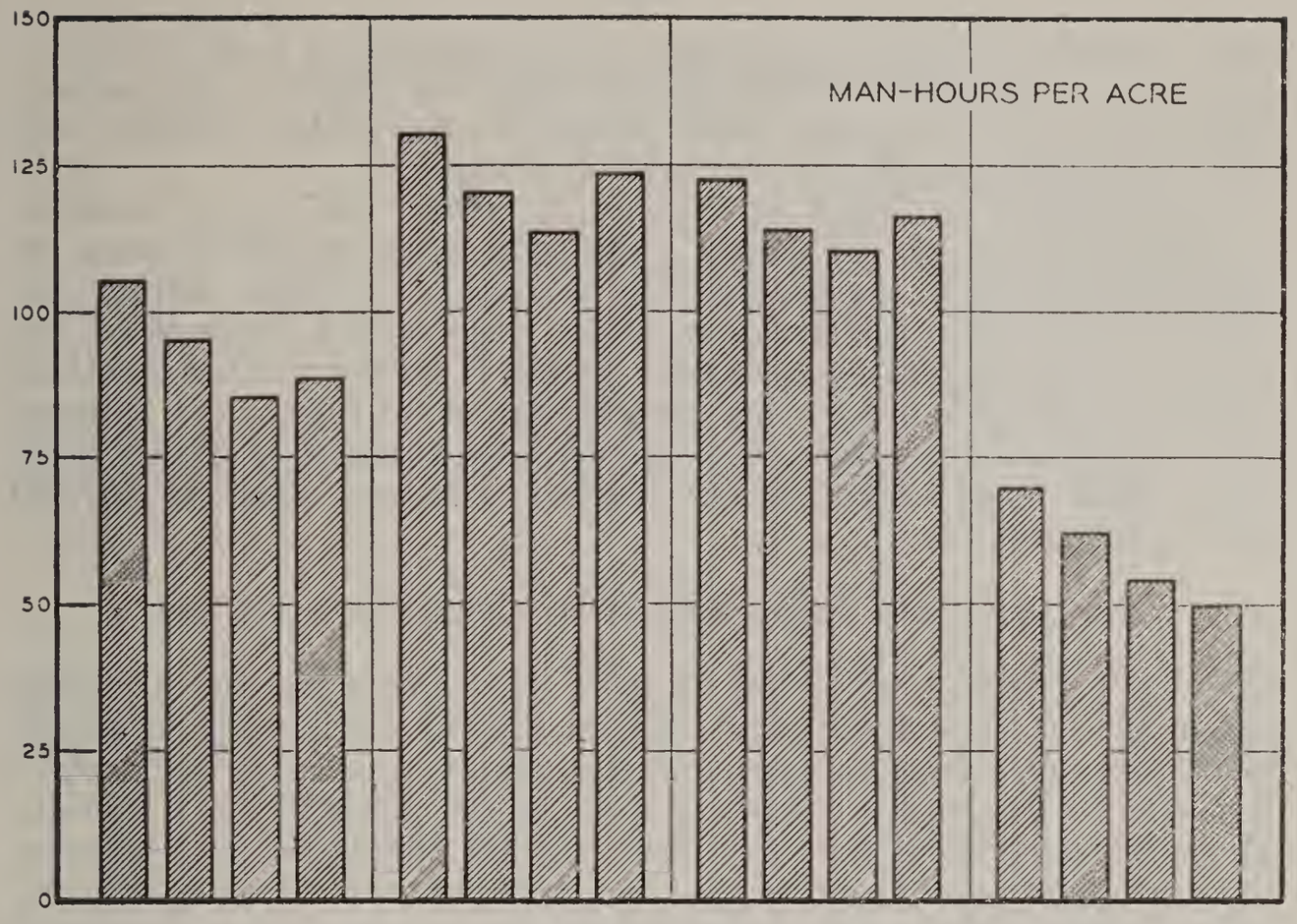
The western semiarid section has level land and a climate which results in very little weed growth. Multirow equipment, widespread use of tractors, and the performance of fewer operations are responsible for the small amounts of labor used here. Preharvest labor in 1936 averaged only 11.6 hours an acre and the total was 26.5 hours. Yields are low and much of the cotton is snapped or sledded, so that considerable trash is collected with the cotton. Cotton grown is of shorter staple and poorer quality than in the older cotton sections. Thus, the advantage of this section is not at all measured by the relatively small number of hours an acre.

Trends of Labor Requirements in Cotton Production

Since 1909 the estimated number of hours spent in raising an acre of cotton in the eastern cotton area has changed very little (table 43). The principal variations have come from the year-to-year fluctuation in yield which affects labor requirements in picking the crop. In the three delta States of Arkansas, Louisiana, and Mississippi, labor per acre has declined only a little in spite of the mechanization in plantation sections.

The greatest reduction in labor has occurred in the western cotton area, largely because of the adoption of larger equipment and more power. This should be qualified, however, because the western area has a rapid expansion in cotton acreage, with the greatest increase occurring in the western part, which is better adapted to mechanization. The total reduction from these combined influences amounted to 29 percent in the labor per acre since 1909–11, while per bale it was only 18 percent in the western cotton and the delta area, and 15 percent in the eastern cotton and the middle eastern areas.

Total amount of labor used in production of cotton was estimated at approximately 3.3 billion hours per year in the period 1907–11, and at 3.5 billion in 1927–31. Average requirements during 1933–36 were lower by approximately a quarter because of drought and the Agricultural Adjustment Administration program. These figures hide larger changes in individual areas. Between 1907–11 and 1927–31, cotton acreage contracted 18 percent in the eastern cotton area and increased from 30 to 60 percent in the middle eastern, delta, and western cotton areas, with the largest increase in the lat-



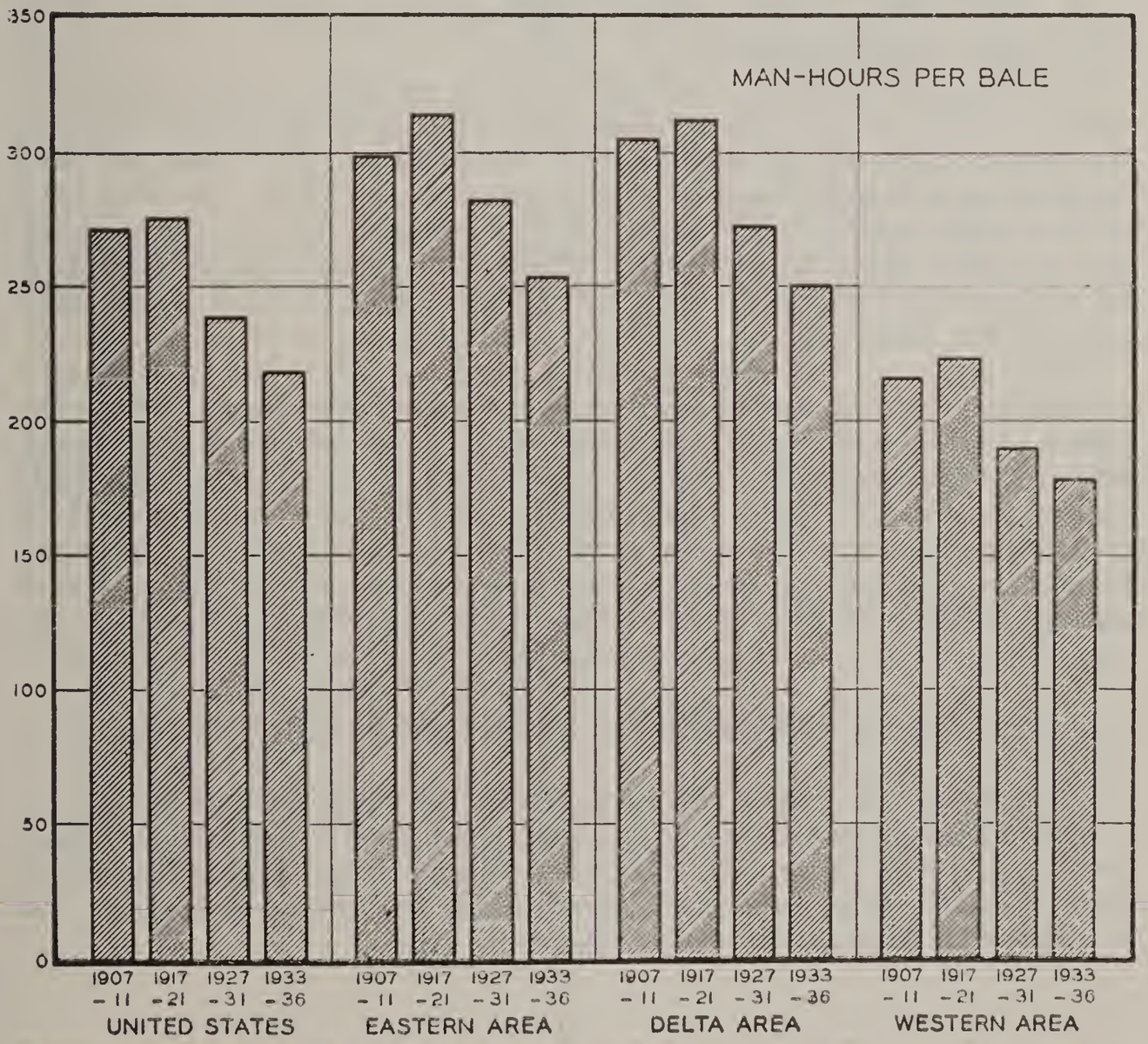


FIGURE 26.—Changes in labor per acre and per bale in producing cotton for specified areas and for the United States, 1909–11 to 1933–36.

Source: Based on data in table 29, *Changes in Technology and Labor Requirements in Crop Production: Cotton*, WPA N. R. P. Report No. A–7.

ter. Combined effects of changes in acreage and in methods are to be seen in a decrease of 28 percent in labor on cotton in the eastern cotton area, and increases of 21 percent in the middle eastern, and 24 percent in the delta and western cotton areas.

Net increase in labor on this crop from 1907–11 to 1927–31 amounted to 150 million hours. This was made up of increases of 209 million hours in the western, 189 million in the delta, and 60 million in the middle eastern area, while there was a decrease of 384 million in the eastern cotton area. If the farm year in the South is counted as 2,500 hours (which may be somewhat high), the increase in the western cotton area was equal to approximately 80,000 man-years, while the decline in the eastern area was equal to 154,000 man-years annually.

Prospects for Employment in Cotton Production

In the production of cotton we have rapid and advanced mechanization in the western semiarid section, partial mechanization in the black waxy and delta sections, and in contrast, practically unchanged methods in the eastern sections and in the western hilly section. These latter sections have provided a great amount of employment in the production of this crop, but at a very low rate of remuneration. The strongest reason for continued production at such a disadvantage is to be found in the lack of alternative opportunities for persons working in the cotton fields.

Even though it has not yet been found possible to mechanize cotton chopping or picking, available opportunities of saving labor in the preparation of the seedbed and in cultivation have been adopted by relatively few farmers in the older cotton sections. A shift even to two-horse outfits would accomplish a considerable saving of labor, and not only these but tractor outfits are now being adopted in appreciable numbers wherever the land is level enough and fields large enough for their use.

Some reduction of employment during the next few years seems probable. This change is limited by at least three important resistances: (1) The adoption of larger and more effective equipment, especially that drawn by tractors, is limited by small, irregular fields in many sections; (2) a tendency is noted to keep enough workers on the farm during the early part of the season to meet the requirements for picking the crop; (3) a large degree of inertia is found among farmers with regard to changes in practices. Therefore, the changes that occur probably will be slow.

LABOR REQUIREMENTS IN POTATO PRODUCTION

Potatoes are grown in every State in the country, but constitute a major crop in relatively few commercial producing areas. These are located chiefly in the northern States from Maine to North Dakota, with other centers of production in Idaho, Colorado, and in the South Atlantic States for the early crop.

TABLE 43.—*Total labor in producing cotton* [1]

ACRES HARVESTED [1]

Period	United States [2]	Major cotton-producing areas				
		Eastern area	Middle eastern area	Delta area	Western area	Irrigated area [3]
	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*
1907–11	31,759	10,483	2,041	6,480	12,374	4
1917–21	32,655	9,282	2,204	6,489	14,208	201
1927–31	41,031	8,598	2,608	8,927	19,875	532
1933–36	28,410	5,800	1,836	6,364	13,443	513

MAN-HOURS REQUIRED PER ACRE [5]

	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
1907–11	105	130	139	122	70	122
1917–21	95	120	136	114	62	109
1927–31	85	113	132	110	54	118
1933–36	88	123	130	116	50	127

MAN-HOURS REQUIRED ON TOTAL ACREAGE

	Mil. hours	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*
1907–11	3,343	1,358	285	793	863	(6)
1917–21	3,089	1,115	301	738	883	22
1927–31	3,493	974	345	982	1,072	63
1933–36	2,489	716	238	739	673	65

COTTON PRODUCED [4]

	1,000 bales	*1,000 bales*	*1,000 bales*	*1,000 bales*	*1,000 bales*	*1,000 bales*
1907–11	12,332	4,536	1,072	2,597	3,997	3
1917–21	11,219	3,550	1,132	2,369	3,967	102
1927–31	14,658	3,452	1,291	3,615	5,651	416
1933–36	11,432	2,832	1,055	2,955	3,791	515

MAN-HOURS USED PER BALE [7]

	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
1907–11	271	299	266	305	216	163
1917–21	275	314	266	312	223	216
1927–31	238	282	267	272	190	151
1933–36	218	253	226	250	178	126

[1] Based on data from N. R. P. Farm Survey, 1936, and from earlier studies conducted by the U. S. Department of Agriculture and by State experiment stations. Labor requirements for marketing (when cotton was not sold at gin) are excluded from the estimates.

[2] Includes all cotton-producing States.

[3] Includes New Mexico, Arizona, and California.

[4] Based on figures from Appendix A, WPA N. R. P. Report No. A-7.

[5] Hours are per acre harvested, but include estimated hours spent on abandoned acreage. See Appendix E, WPA N. R. P. Report No. A-7.

[6] Less than 500,000.

[7] 500-pound bale, gross weight (includes bagging and ties and contains about 478 pounds of lint). Labor on abandoned acreage is included.

Source: William C. Holley and Lloyd E. Arnold, *Changes in Technology and Labor Requirements Crop in Production: Cotton*, WPA N. R. P. Report No. A-7, table 29, p. 103.

In the Field Study of 1936 information was obtained on methods and labor requirements in six northern counties from Minnesota to Maine. In five of these counties from 68 to 79 hours of labor were spent per acre in 1936. In Clay County, Minnesota, however, more extensive methods of production were used and the labor amounted to only 36 hours per acre, but yield was also lower than in the other counties. As with other crops, practices varied from one area to another, and the amount of labor varied with practices, with type and size of equipment, and with yield.

Trends in Labor Requirements on Potatoes

Potato acreage has decreased slightly in the Eastern and Northern States and has increased in other areas, particularly in the West. In the eight States included in table 44, about 35 million fewer man-hours were used annually in growing potatoes in 1934–36, partly because of decreased acreage and partly because of improved methods. When the expansion in acreage elsewhere is taken into account, it is likely that the net change in employment provided by this crop is only 10 or 15 million man-hours.

It is estimated that the average number of hours per acre of potatoes was reduced from 89 in the 1909–13 period to 76 in 1934–36 (table 44). During this interval average yield rose from 98 to 107 bushels an acre. Consequently, there was a greater reduction in the hours used to grow 100 bushels than in the labor required for an acre. The higher yields resulted from several different influences, among which may be mentioned the planting of more seed to an acre, improved varieties, and a shift of acreage into higher yielding areas. The decline in hours per acre was largest in the more specialized potato-producing areas. These trends seem likely to continue but to be gradual and the decline in employment is likely to be slow.

LABOR REQUIREMENTS IN TRUCK-CROP PRODUCTION

Part of the decline in employment in production of major crops has been offset by an increase in production of truck crops. Although there are many vegetable crops, the seven most important in terms of value are sweetpotatoes, tomatoes, lettuce, muskmelons, snap beans, onions, and cabbage, in the order given. During 1924–29, vegetable crops occupied less than 1 percent of the total crop acreage, but their value was more than 3 percent of the total value of crops. During the same years labor spent in the production of 15 principal vegetable crops was greater than that used on either wheat or oats. The most important commercial vegetable-crop areas are located along the Atlantic seaboard, along the Gulf Coast, in California, in small scattered sections in the Middle West, and in the range area.

From 1918–21 to 1932–36 the acreage in 14 vegetables raised commercially for market has increased from 133,000 to 240,000 acres, while eight truck crops for manufacture rose from 70,000 to 109,000 acres. Increases in acreage were widespread but the greatest relative expansion occurred in the western cotton, range, California, and northwestern areas. Production, however, increased less than acreage, since the yield per acre declined 18 percent from 1918–21 to 1932–36. This was caused partly by droughts in recent years and partly because vegetable production expanded onto less productive land.

TABLE 44.—*Estimates of labor used in producing potatoes in selected areas, 1909–36* [1]

ACRES IN POTATOES [2]

Period	Total selected areas [2]	Minnesota, Wisconsin, and Michigan	Pennsylvania, New York, and Maine	New Jersey and Virginia
	10,000 acres	*10,000 acres*	*10,000 acres*	*10,000 acres*
1909–13	182	88	77	17
1917–21	187	95	71	21
1927–31	162	85	62	15
1934–36	168	91	63	14

PRODUCTION [3]

	Mil. bu.	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*
1909–13	205	94	92	19
1917–21	199	89	84	26
1927–31	193	76	94	22
1934–36	200	76	105	19

HOURS PER ACRE

	Hours	*Hours*	*Hours*	*Hours*
1909–13	89	80	102	78
1917–21	86	73	102	83
1927–31	79	66	98	72
1934–36	76	65	94	65

HOURS PER BUSHEL

	Hours	*Hours*	*Hours*	*Hours*
1909–13	0.79	0.74	0.86	0.70
1917–21	.80	.78	.85	.69
1927–31	.66	.74	.64	.49
1934–36	.64	.78	.56	.48

TOTAL LABOR IN MILLIONS OF HOURS

	Hours	*Hours*	*Hours*	*Hours*
1909–13	162.1	70.1	78.7	13.3
1917–21	159.3	69.3	72.2	17.8
1927–31	127.3	56.2	60.2	10.9
1934–36	127.4	59.0	59.0	9.4

[1] Source: Harry E. Knowlton, Robert B. Elwood, and Eugene G. McKibben, *Changes in Technology and Labor Requirements in Crop Production: Potatoes*, (W. P. A. N. R. P. Report No. A-4) table 14, p. 68.
[2] Average for each area weighted by acreage in respective areas.
[3] Data from Bureau of Agricultural Economics, U. S. Department of Agriculture.

TRENDS IN LABOR REQUIREMENTS ON TRUCK CROPS

In most parts of the country truck farms are too small to permit much mechanization. Also, close spacing of plants and habits of growth of many vegetables make it necessary to perform considerable hand work. Further, vegetables which are to be marketed fresh require much more labor in harvesting, grading, and packing than do those which are to be canned or manufactured.

Labor requirements per acre vary widely with the nature of the crop, acreage per farm, degree of mechanization, the yield, and whether the crop is raised for sale as fresh vegetables or is used for manufacture. For the United States as a whole, it is estimated that an average of 135

hours an acre was used in 1932–36 in producing vegetable crops for market and 65 hours for vegetables for manufacture.

Seven percent less labor was used an acre of vegetable crops in 1932–36 than in 1918–21. For individual crops the decline was somewhat greater, but a shifting of acreage to crops with high labor requirements took place. The greatest declines occurred in California and the corn area where mechanization was more rapid and where yield decreased. Vegetables for manufacture were mechanized to a greater extent than those for market, and their labor requirements declined 19 percent, with the greatest reduction in the western dairy and the northwestern area.

With declining yields, the hours per unit of vegetable crops produced actually rose about 5 percent from 1918–21 to 1932–36, for the United States. The greatest increases occurred in the middle eastern area, the cotton areas, and the small-grain area, while there were declines or only small increases in the dairy areas, the corn area, and the far western areas.

Commercial production of vegetables in 1932–36 required an estimated total of 393 million man-hours annually, which represents 143 million hours more than in 1918–21 (table 45). In 1909, total labor in vegetable production was only about 200 million hours for the 15 crops included in this study, according to census acreages multiplied by the numbers of hours an acre found for 1918–21. Thus, the increase in labor used in commercial production of vegetables since 1909 is about equal to the decline in hours used to produce wheat, or is half as great as the reduction in labor in corn production.

Prospects for Employment in Vegetable Production

It is probable that the figures just given overstate somewhat the increase in total labor used on vegetables because they refer to commercial vegetable production only. Since 1909 a shift toward production of vegetables for shipment or for manufacture has taken place with a relative decline in production in home and market gardens.[2] Another development of importance has been the shift by the consuming public to consumption of vegetables rather than meats or cereals. This movement may continue for some time, but the probabilities are that it will be at a less pronounced rate than during the last two or three decades.

Mechanization and improvement in methods of vegetable production are continuing and may for a while offset increased demand in its effect on labor requirements. Then the growth of the frozen vegetable industry, which has been expanding rapidly in the recent past, seems capable of increasing the volume of production and the amount of employment. Taking all of these influences into account, the trend toward greater vegetable production appears to be as yet incomplete, although the growth of production and of employment seem likely to proceed more slowly than during the last quarter century.

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[2] Figures for production in home and market gardens are not included in the acreage and production figures of the U. S. Department of Agriculture, on which the estimates given here are based.

TABLE 45.—*Estimated labor requirements for production of 15 vegetable crops, by areas, 1918–36* [1]

Period	United States	Corn area	Eastern dairy area	Western dairy area	Middle eastern area	Eastern cotton area	Delta cotton area	Western cotton area	Small grain area	Range area	Northwestern area	California
Crops for market:[2]	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*
Acres harvested:[3]	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*
1918–21	1,333	77	109	25	244	406	201	146	4	20	5	94
1927–31	1,920	92	145	37	301	486	216	235	5	87	25	292
1932–36	2,396	116	174	48	355	611	312	303	5	87	37	348
Man-hours per acre:[4]	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
1918–21	145	155	203	183	146	127	142	125	130	164	229	172
1927–31	141	142	188	180	137	123	142	116	127	167	193	155
1932–36	135	124	185	177	132	122	134	115	119	162	195	135
Man-hours on total acreage:	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*
1918–21	193,634	11,980	22,259	4,546	35,716	51,320	28,398	18,166	520	3,263	1,236	16,228
1927–31	271,075	13,034	27,138	6,587	41,144	59,683	30,747	27,328	686	14,575	4,794	45,357
1932–36	322,504	14,433	32,189	8,606	47,100	74,578	41,839	34,744	645	14,111	7,221	47,037
Crops for manufacture:[5]	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*
Acres harvested:[6]	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*
1918–21	701	217	111	140	144	2	5	1	6	17	2	55
1927–31	1,071	318	156	247	167	10	30	5	10	28	6	95
1932–36	1,092	308	153	243	178	11	18	10	8	26	21	116
Man-hours per acre:[4]	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
1918–21	80	64	80	60	105	102	110	89	60	113	98	122
1927–31	64	52	67	39	87	93	89	69	40	98	80	104
1932–36	65	53	70	37	91	90	82	72	47	89	47	103
Man-hours on total acreage:	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*
1918–21	56,435	14,001	8,839	8,338	15,082	235	574	98	382	1,905	235	6,746
1927–31	68,687	16,596	10,516	9,709	14,524	929	2,654	318	392	2,708	510	9,832
1932–36	70,918	16,258	10,668	9,014	16,157	1,024	1,490	699	377	2,275	977	11,979

[1] Source: WPA N. R. P. Report No. A-12, *Changes in Technology and Labor Requirements in Crop Production: Vegetables*, by J. C. Schilletter and others, 1939, table 15 p. 83.

[2] Asparagus, beans (snap), cabbage, cauliflower, celery, cucumbers, lettuce, muskmelons, onions, peas, spinach, sweetpotatoes, tomatoes, and watermelons.

[3] Based on table A-1; of Report A-12, computed from unrounded figures.

[4] Average of labor requirements per acre of individual crops from tables 6–13, and D-1 of Report No. A-12, weighted by acreage.

[5] Asparagus, beans (snap), cabbage, corn, cucumbers, peas, spinach, and tomatoes.

[6] Based on table A-2 of Report No. A-12; computed from unrounded figures.

LABOR REQUIREMENTS IN DAIRY PRODUCTION

Mechanization in livestock production has lagged far behind that on crops; consequently there has been less saving in labor requirements on livestock. Each animal in dairy or beef cattle herds needs at least some individual oversight. In hog production the same is true of the sows at breeding and farrowing times. Fattening pigs and flocks of poultry require less individual care.

Amount of labor spent in livestock production may be affected either directly through changes in handling the animals, or indirectly through changed methods of producing crops for livestock feed. Direct changes may come through any one of three principal sources: (1) improvement in the physical equipment used in the livestock enterprises, (2) changes in operations performed or in their efficiency, or (3) change in size of the average farm enterprise which affects labor efficiency.

In dairy herds mechanization has been limited to the adoption of milking machines in larger dairies, installation of feed and litter

carriers, water cups at the stalls, and so on. Such changes in the smaller dairies have been few. In hog production and in the fattening of steers, the increased use of self-feeders has reduced labor requirements. A probable gain has resulted from a general improvement in the layout of stables, poultry houses, feeding lots, etc., but the effect from this is relatively small and very hard to measure. Increases in animals per herd or flock, particularly of cows and hens, have undoubtedly lowered labor requirements for these animals, as fewer hours are needed per animal and per unit of product in the larger enterprises, at least up to a certain size.

Labor required to raise livestock products for the nation is also affected by the available livestock technology as described in certain respects in the preceding chapter. Improvement of breeds has made for higher-producing cows, hogs, and poultry and this has reduced the amount of labor needed per unit. Improved methods of disease control also have made for higher production in general, although a part of the gain has been offset by new outbreaks of disease.

Trends in Dairy Production

From 1909–13 to 1932–36 the total number of cows milked in the United States increased approximately 40 percent (table 46). The eastern dairy area was the only one which had no increase. The largest absolute expansion occurred in the western dairy area and the largest percentage increases were in the range and northwestern areas. Milk production per cow rose approximately 11 percent for the United States as a whole. Increases amounted to more than 20 percent in California and the northwestern area, and less than 10 percent in the small-grain area and the southern areas.

Labor per cow varies with number of cows per herd, amount of care needed to meet sanitary regulations, number of days the cows run on pasture, number of times per week that it is necessary to deliver the milk or cream, and, of course, with production per cow. Total labor per milk cow was estimated at 140 hours for the United States in the period 1932–36, an increase of about 4 percent since 1909–13. This covers labor on milk cows only, and does not include care of bulls or young dairy stock. Labor runs higher than this in areas which produce market milk, like the eastern and western dairy areas and in the Pacific Coast States. In the corn and small-grain areas hours per cow are relatively lower because many of the cows are milked incidentally to beef production and do not receive very intensive care. Also, most of the product is sold as cream, which is delivered only 2 or 3 times per week.

With the production per cow rising 11 percent since 1909–13, and the direct labor per milk cow only 4 percent, labor per 1,000 pounds of milk decreased 6 percent or 7 percent.

Total Labor Required by the Dairy Enterprise

At an estimated 140 hours per milk cow during the period 1932–36 the 24.2 million milk cows required a total of slightly over 3⅓ billion hours of labor per year, an increase of 1 billion man-hours since 1909–13. This is not the total amount of labor for the enterprise, since additional work must be spent in raising calves and heifers for replacements.

TABLE 46.—*Estimates of labor requirements of milk cows in the United States and major areas, 1909–13 to 1932–36* [1]

NUMBER OF COWS MILKED

Period	United States	Eastern dairy area	Western dairy area	Corn area	Middle eastern area	Cotton area	Small grain area	Range area	Northwestern area	California area	Other States
	Thousands	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*
1909–13	17,330	2,851	2,890	3,284	1,580	2,933	1,688	298	410	412	984
1917–21	19,830	2,932	3,789	3,474	1,786	3,271	2,087	430	553	486	1,022
1927–31	21,528	2,700	4,210	3,801	1,938	3,417	2,582	534	660	598	1,088
1932–36	24,202	2,806	4,571	4,255	2,198	4,164	2,846	553	751	615	1,443

MILK PRODUCTION PER COW

	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1909–13	3,802	4,551	4,466	3,754	3,354	2,715	3,468	3,779	4,532	5,408	3,411
1917–21	3,781	4,756	4,435	3,805	3,290	2,427	3,454	3,433	4,691	5,399	3,219
1927–31	4,529	5,367	5,298	4,532	3,739	3,229	4,181	4,584	5,723	6,296	4,051
1932–36	4,237	5,220	5,033	4,329	3,506	2,929	3,750	4,264	5,477	6,587	3,822

HOURS PER COW

	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
1909–13	135	154	142	112	175	133	106	133	138	125	133
1917–21	138	154	146	119	174	132	112	132	141	130	136
1927–31	139	150	150	123	174	132	116	132	143	135	141
1932–36	140	150	156	121	174	132	116	132	143	135	142

HOURS PER 1,000 POUNDS OF MILK

	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
1909–13	35.5	33.8	31.7	29.9	52.2	49.0	30.5	35.2	30.5	23.1	38.9
1917–21	36.5	32.3	32.8	31.1	52.9	54.6	32.4	38.5	30.1	24.1	42.3
1927–31	30.7	28.0	28.3	27.1	46.5	40.9	27.6	28.9	25.0	21.4	34.8
1932–36	33.0	28.8	31.4	27.9	49.6	45.0	30.9	31.1	26.1	20.5	37.1

TOTAL LABOR ON MILK COWS [2]

	Mil. hours	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*
1909–13	2,341	438	410	369	276	390	179	40	57	52	131
1917–21	2,730	451	552	412	311	433	233	57	78	63	139
1927–31	2,991	406	632	468	337	452	298	71	94	81	153
1932–36	3,378	422	713	514	382	549	330	73	107	83	205

[1] R. B. Elwood and others, *Changes in Technology and Labor Requirements in Dairying* (WPA N. R. P. unpublished report, 1939).

[2] Computed from unrounded hours per cow.

When the time spent on young stock and bulls is added to that spent on milk cows, it is found that total labor used on all dairy cattle amounted to about 3.7 billion hours annually in 1932–36, as compared to 2.6 billion in 1909–13 (table 47). The total for the recent period was greater than the amount of labor used on any other single farm enterprise.

TABLE 47.—*Labor used on all dairy cattle, total and per 5,000 pounds of milk*

Item	Unit	1909–13	1917–21	1927–31	1932–36
Hours on cows	Mil. hours	2,341	2,730	2,991	3,378
Raising calves and heifers	do	149	174	188	216
Care of bulls	do	61	70	76	85
Total man hours [1]	do	2,551	2,975	3,255	3,679
Milk production	Mil. pounds	65,894	74,978	97,497	102,543
Hours per 5,000 pounds milk on all dairy cattle.	Hours	194	198	167	179
Producing feed [2]	do	58	58	54	56
Total hours	do	252	256	221	235
Feed per 5,000 pounds milk:					
Concentrates [2]	Pounds	1,719	1,616	1,603	1,535
Dry roughages [2]	do	7,409	6,768	6,134	6,512
Silage [2]	do	1,057	3,439	2,995	3,071
Land to grow above feed per 5,000 pounds milk.	Acres	4.34	4.17	3.87	3.99

[1] From WPA N. R. P. Report (unpublished) *Changes in Technology and Labor Requirement in Livestock Production: Dairying*, by R. B. Elwood, A. A. Lewis, and R. A. Struble, table 25 [mimeographed].
[2] Ibid., table 27 [mimeographed].

Some idea of the relative importance of the dairy enterprise may be gained from the fact that, when time spent on replacement stock and in care of the bulls is included, the enterprise, in 1932–36, used nearly half again as much labor as the cotton crop, 1.6 times as much as the corn crop, and more than 5 times as much as the wheat and oats crops combined. Compared with other enterprises, dairying is most important in the eastern and western dairy areas and least important in the cotton areas. It is a striking fact that dairying provided more hours of employment than the corn crop in the corn area, and more than wheat and oats combined in the small-grain area. As milk cows require more time in winter than in the crop-growing season, the increase in dairying makes for more complete year-round utilization of available labor rather than for the employment of a greater number of persons.

The increase of 1.1 billion man-hours in labor used on dairy cattle since 1909–13 was slightly more than the combined reductions in labor spent on corn, wheat, and oats. It was, however, more widely distributed over the country and was also differently distributed over the year.

CHANGES IN FEED REQUIREMENTS IN DAIRY PRODUCTION

Production of milk or of any other livestock product requires two separate processes; one the actual care and feeding of the livestock, and the other the production of the required feed. Changes in feed requirement per cow and per unit of milk production also have an important influence on agricultural employment, as these changes have affected crop acreage and the amount of labor required to raise feed crops.

During the last quarter-century the amount of silage per cow has increased decidedly; the amount of dry roughage has decreased; but concentrates have changed relatively little. High-producing cows require more digestible nutrients than the poorer producers, but in order to consume the full amounts needed for their best production it is necessary to increase the feeds which have more nutrients per unit of bulk and to reduce the amount of roughage.

With the large increase in quantity of silage fed per cow went a rise in total pounds of feed per unit of milk produced. But the corn contained in the silage more than offset the decline in concentrates, and most of the remainder of silage is water. Thus, pounds of digestible nutrients per unit of milk were smaller in more recent periods Improvements in feeding and in breeding of more productive cows are estimated to have saved in the production of feed for milk cows alone an average of 1.9 hours per 5,000 pounds of milk. This amounts to 37 million man-hours on the 1927–31 volume of milk production. Also, the shift from dry roughage to silage crops meant a decline of 10 percent in crop acreage needed to feed the dairy cows between 1910–13 and 1927–31.

Other influences have also contributed to the reduction of labor used in the dairy since 1909. With increasing commercialization of dairy farming and the demand for a more sanitary product, a notable shift of functions from the dairy farm to the processor and distributor of dairy products took place. The manufacture of butter and cheese, once an important function of many dairy farms, is now done largely in town factories. An increase in the practice of pasteurizing and bottling market milk has added further to the nonfarm labor. Thus, a larger proportion of the total labor used on dairy products is now employed in urban centers than at the beginning of the period under study.

LABOR REQUIREMENTS IN POULTRY PRODUCTION

Poultry production, like dairying, has expanded to such a degree that it requires much more labor than in 1909. In 1927–31 there was an average of 458 million chickens on farms in the United States. The enterprise produces both eggs and meat. Consequently comparisons of production per head and of labor requirements per hundred eggs are likely to be misleading. In some areas the enterprise is specialized in one direction and in some in another direction as shown by table 48.

TABLE 48.—*Poultry and egg production, by regions*

Area or region	Percentage of Nation's chickens	Percentage of egg production	Percentage of live weight production
	Percent	*Percent*	*Percent*
Grain-producing regions (corn and small-grain areas)	34	33	39
Dairy areas	16	21	20
Western regions (California, range, and northwest)	10	12	7
Southern areas (including middle eastern)	29	25	25

The poultry enterprise has expanded even more rapidly than dairying, with chickens on farms increasing 36 percent from 1910 to 1927–31 (table 49). Information on the amount of labor used in caring for chickens is available from various farm-management studies made by agricultural experiment stations and by the United States Department of Agriculture. From such data the labor on all chickens was estimated to average 2.15 hours per chicken for the country as a whole in 1933–35. It ranged from 1.9 hours per chicken in the western cotton area and California to 2.5 in the middle eastern area. At these rates 985 million hours per year were spent on chickens in this period.

Since studies in the earlier years are few and show wide variation, it was not possible to prepare accurate estimates of changes per chicken since 1909. It is apparent, however, that the increase in numbers of chickens has been the source of most of the change in total labor on poultry. The figures shown in table 49 represent the changes in total amounts of labor on chickens caused solely by changes in their numbers.

During the last quarter century some influences have tended to decrease and some to increase the labor required per chicken. Those tending toward decrease in such labor are improvements in poultry buildings and equipment; the shift of an important percentage of the hatching of chicks to commercial hatcheries; adoption of trucks and automobiles for hauling poultry products as well as supplies, and an increase in average size of farm flocks. Increasing trouble with disease, particularly among large commercial flocks of laying hens, has tended to increase the labor required. Furthermore, a shift from a farm to a commercial type of flock apparently involves some increase in the amount of labor required per bird. The farm flock ranges for itself and obtains a large part of its feed from farm waste. The commercial flock requires more intensive care and all its feed must be furnished specially.

During 1932–36 chickens required 903 million hours of work annually, equivalent to 300,000 man-years of 3,000 hours each. This is equal to approximately 3 times as much labor as the oat crop and 2½ times as much as the wheat crop.

From 1909 to 1927–31 figures indicate that the growth in number of chickens called for an added 258 million hours, or about 85,000 man-years. Among major regions, the corn area has had the smallest proportionate increase in chickens and, consequently, in labor spent on this enterprise. The number has more than doubled in California, the range area, and the northwestern areas. Elsewhere numbers have increased about 50 percent.

The increase in labor on chickens since 1909 has been about half as great as the decline in labor on corn and one-fifth greater than the decline on wheat, but only one-fourth as great as the increase in labor on all dairy cattle.

Much of the labor on farm chickens is performed by the farmer's wife and children, although men ordinarily do the heavier work. Therefore on farm flocks, as distinguished from commercial flocks, the greater part of the increase has meant more complete utilization of labor already available rather than employment of a larger number of persons. Greater employment has resulted only in the more intensive poultry sections.

TABLE 49.—*Number of chickens on farms, production of meat and eggs, and amounts of labor used on chickens, estimated at requirements in recent years, United States and major areas, for specified periods, 1909–38*

NUMBER OF CHICKENS ON FARMS[1]

Year	United States	Corn area	Eastern dairy area	Western dairy area	Middle eastern area	Eastern cotton area	Delta cotton area	Western cotton area	Small grain area	Range area	Northwestern area	California
	Millions	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*
1910	336	88	32	35	38	15	16	25	40	4	6	7
1920	360	90	29	36	45	17	17	29	42	6	8	10
1927–31	458	100	39	46	52	20	21	41	55	10	14	20
1932–36	420	93	39	46	50	19	20	36	50	9	12	16
1937–38	402	88	40	46	49	20	21	34	38	9	12	16

EGG PRODUCTION[1]

	Millions	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*	*Millions*
1909	23,625	5,821	2,727	2,448	2,655	802	919	1,841	2,629	342	520	611
1919	26,399	6,574	2,621	2,705	3,019	948	1,039	1,846	3,006	471	712	1,023
1927–31	38,561	8,199	3,965	4,082	3,935	1,241	1,292	3,179	4,486	928	1,622	2,062
1932–36	34,708	7,342	4,101	4,134	3,585	1,131	1,126	2,724	3,479	835	1,441	1,806
1937–38	37,322	7,879	4,788	4,712	3,878	1,279	1,358	2,902	3,298	882	1,480	1,926

LIVE WEIGHT PRODUCTION[2]

	Mil. lbs.	*Mil. lbs.*	*Mil. lbs.*	*Mil. lbs.*	*Mil. lbs.*	*Mil. lbs.*	*Mil. lbs.*	*Mil. lbs.*	*Mil. lbs.*	*Mil. lbs.*	*Mil. lbs.*	*Mil. lbs.*
1927–31	2,461	607	221	273	245	84	89	199	341	50	65	55
1932–36	2,392	599	230	280	266	84	93	157	315	44	50	43
1937–38	2,173	546	242	248	262	82	106	136	259	42	42	42

HOURS PER CHICKEN[3]

	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
1933–35	2.15	2.1	2.3	2.2	2.5	2.0	2.0	1.9	2.1	2.2	2.2	1.9

TOTAL LABOR ON CHICKENS, AT 1933–35 RATES PER CHICKEN

	Mil. hours	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*
1910	722	185	74	77	95	30	32	48	84	9	13	13
1920	774	189	67	79	112	34	34	55	88	13	18	19
1927–31	985	210	90	101	130	40	42	78	116	22	31	38
1932–36	903	195	90	101	125	38	40	68	105	20	26	30
1937–38	864	185	92	101	122	40	42	65	80	20	26	30

[1] Data for years prior to 1927 are based on the *Thirteenth and Fourteenth Censuses.* Census data for number of chickens in 1910, enumerated in April, were increased 20 percent for comparability with later data enumerated in January. Census data for egg production in 1909 were increased 25 percent because of incomplete enumeration; census data for 1919 which were enumerated in January when egg production is low, were increased 33 percent to compensate for difference in completeness of enumeration as compared to later data and for the tendency of farmers to be influenced in their reports of total annual production by the level of egg production at the time of enumeration. Data for numbers of chickens and egg production for 1927–38 are latest revisions of the Crop Reporting Service Estimates. Figures for number of chickens consist of averages of numbers on hand Jan. 1 at the beginning, and end of each year.

[2] Number of chickens produced on farms multiplied by estimated weight of chickens by States, obtained from U. S. Department of Agriculture, Bureau of Agricultural Economics. Data for chickens produced not available for years before 1925.

[3] Based on data from farm-management studies made by the U. S. Department of Agriculture and State experiment stations.

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With the shortage of feed caused by droughts and with low prices for farm products from 1930 to 1935, the total number of chickens in the United States showed a decline of 14 percent. It seems likely, however, that most of the decline was temporary and that egg production will continue to expand at least as rapidly as the population of the country for some years. With improved methods of breeding, feeding, and managing the chickens, particularly in commercial flocks labor per 100 eggs may decline enough to offset part of this expansion.

Before leaving the subject of employment in poultry production, it should be pointed out that in the last decade there has also been a pronounced increase in production of turkeys. Development of a technique of handling these fowls in large numbers without serious disease loss has led to the establishment of an important enterprise on many farms. Since chickens are carriers of certain diseases to turkeys, the latter tend to be produced, in the larger and more up-to-date flocks, as a separate enterprise, or even on separate farms from the chickens. This development of turkey production adds new competition to the production of chickens and other animals for meat.

LABOR REQUIREMENTS IN HOG PRODUCTION

About 40 percent of the total weight of hogs is produced in the corn area. This proportion has changed only a little since 1909–13. Second in importance comes the small-grain area which produced 14 percent in 1909–13, 20 percent in 1927–31, and 15 percent in the drought years 1932–36.

Changes in Labor Per 100 Pounds Live Hogs

Labor required to produce 100 pounds of live hogs varies with methods used, with climate, and with other environmental conditions. It changes inversely with the number of hogs raised per farm. In the corn area average production per farm in 1932–36 was approximately 6,500 pounds; in the western dairy area, 2,700 pounds; and in the middle eastern area, 900 pounds.[3]

Various changes in methods of handling the hogs, increases in the use of legume pastures, use of self-feeders, and greater production of pork in major hog-producing areas where labor requirements are low brought a decline in the direct labor required to produce 100 pounds of pork of about 10 percent between 1909–13 and 1927–31 (table 50). Average labor requirements in 1932–36, however, were higher than in the late 1920's, largely because hog production in the corn and small-grain areas, where labor requirements are low, was decreased by drought and shortage of feed.

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[3] Production figures from table 50 divided by average numbers of farms for the respective areas, from N. R. P. Report No. A–8, *Trends in Employment in Agriculture,* table B–1, page 113.

TABLE 50.—*Estimated amounts of labor and feed used in hog production for major hog-producing areas, selected periods, 1909–36*

ANNUAL PRODUCTION[1]

Year	United States	Corn area	Western dairy area	Small grain area	Middle eastern area
	Mil. lbs.	*Mil. lbs.*	*Mil. lbs.*	*Mil. lbs.*	*Mil. lbs.*
1909–13	11,947	4,482	1,131	1,632	1,110
1917–21	13,875	5,242	1,452	2,032	1,251
1927–31	15,965	6,328	1,892	3,264	970
1932–36	13,700	5,621	1,579	2,099	1,005

MAN-HOURS PER 100 POUNDS PRODUCED[2]

	Hours	*Hours*	*Hours*	*Hours*	*Hours*
1909–13	4.48	2.68	6.31	2.97	7.66
1917–21	4.49	2.77	6.33	2.99	7.77
1927–31	4.03	2.51	6.37	2.99	7.77
1932–36	4.21	2.53	6.36	2.97	7.76

TOTAL LABOR ON HOGS

	Mil. hours	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*
1909–13	535	120	71	48	85
1917–21	623	145	92	61	97
1927–31	643	159	121	98	75
1932–36	577	142	100	62	78

POUNDS FEED PER 100 POUNDS HOGS[3]

	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1909–13	476	500	520	490	474
1917–21	456	477	491	475	455
1927–31	440	457	465	452	444
1932–36	437	455	461	448	443

[1] Data from Bureau of Agricultural Economics; for annual data see WPA N. R. P. Report No. A–6, table A–103.

[2] Estimated from various publications of agricultural experiment stations and the U. S. Department of Agriculture.

[3] Includes grains and principal protein supplements but excluding certain minor feeds and excluding peanuts, garbage, and skimmed milk. From Dairy Report [Processed]. Table C–3. Estimated partly from publications of agricultural experiment stations and the U. S. Department of Agriculture and partly from estimates of total production and disposition of principal feeds in Dairy Report [Mimeographed] table C–3.

Changes in Total Labor Used in Hog Production

Total labor used in producing hogs in the United States is estimated at 535 million man-hours annually in 1909–13 as compared to 643 million in 1927–31. In the latter period, hog production was 34 percent greater than before the war, while labor expended was only 20 percent greater. The increase in annual labor on hogs in the corn, small-grain, and western dairy areas amounted to around 140 million hours by 1927–31. In the range, northwestern, and California areas it was about 8 million hours, while in the remainder of the country there was a decline of 39 million man-hours.

Labor Requirements Affected Through Feed Consumption

Hogs are even more important consumers of feed than of labor. Consequently they affect farm employment indirectly through the corn, oat, and barley crops in addition to their direct labor requirements.

It is estimated in table 50, that an average of 476 pounds of feed [4] were required per 100 pounds of hogs raised in 1909–13.

By 1932–36 only 437 pounds were needed. This change does not measure the net gain in feeding efficiency, however, because the production of skimmed milk available for hogs had risen in the meantime, as had the production of hogs on peanuts in the South, and on alfalfa or other pastures. Part of the change undoubtedly represents a gain in efficiency, and, further, pasture requires less labor than grain per unit of feed, while skimmed milk is a byproduct of the growing dairy enterprise.

When the total amounts of gain produced on hogs are multiplied by the feed per 100 pounds, in table 50, the total feed requirements shown in table 51 are found.

Feed consumed by hogs was thus equivalent to more than 40 percent of our corn crop, although it was not all in this form. It included oats, barley, and supplementary feeds as well as corn. If produced in the form of corn at average labor requirements, production of feed used by hogs would require nearly 1 billion man-hours in recent years, and more than 1.1 billion in the earlier periods. If the average hog production of 1932–36 had been produced by the methods and with the feed requirements prevailing in 1909–13, 1,048 million man-hours would have been required even if the feed were raised by present-day methods. This is 86 million more than was actually used.

TABLE 51.—*Estimates of total corn equivalent required in hog production and of labor required to grow feed, selected periods, 1909–36*

Year (average)	Feed required, millions bushels corn equivalent	Millions hours required to grow corn equivalent [1]
	Mil. bu.	*Mil. hours*
1909–13	1,015	1,106
1917–21	1,130	1,153
1927–31	1,254	1,166
1932–36	1,069	962

[1] Computed at average rates of labor requirements for corn production for the United States, WPA N. R. P. Report, No. A-5, table 44; hours per 100 bushels of corn as follows: 1909–13, 109 hours; 1917–21, 102 hours; 1927–31, 93 hours; 1932–36, 90 hours.

CHANGES IN LABOR REQUIREMENTS IN OTHER LIVESTOCK ENTERPRISES

Livestock enterprises other than those just discussed include beef cattle and sheep. In neither of these cases has there been any great change in total labor since 1909, although some shifts of importance between different parts of the country and changes in methods of production have taken place.

Beef or veal is produced in nearly all parts of the country, but by several different processes. In the range sections cattle are raised very largely on pasture. In the Corn Belt beef is often produced as young cattle raised and fattened on farms, or as gain on feeders shipped in from the range sections. In the corn and western dairy areas there are many dual-purpose herds which produce both beef

[4] Grains and major protein supplements, but not including some minor feeding stuffs, nor peanuts, garbage, or skimmed milk.

and milk. In dairy sections veal is a byproduct of milk production and old milk cows are sold for beef after their period of usefulness is ended. Labor in caring for these animals has already been counted under the dairy enterprise. With the increased number of cows milked, a larger proportion of the net beef and veal production consists of byproduct beef and veal from dairy herds.

Changes in the number of cattle other than cows milked, and in the net production of beef and veal are shown in table 52.

TABLE 52.—*Changes in number of cattle other than cows milked and beef and veal production, specified years* [1]

Year	Cattle	Net production of beef and veal
	Millions	*Mil. lbs.*
1909–13	40.4	13.4
1917–21	51.0	14.2
1927–31	38.9	12.8
1932–36	45.3	14.4

[1] Data from Bureau of Agricultural Economics. For annual figures see WPA N. R. P. Report No. A–6, tables A–97, A–98.

On the cattle kept primarily for beef, labor per hundred pounds of production has probably declined somewhat, although there are several conflicting influences: (1) Since the area in ranges has been declining, a larger proportion of beef cattle are now to be found in farm herds and these receive more care and labor per head than range cattle; (2) a decline in the average age and weight at which beef cattle are slaughtered. This means that each hundred pounds of beef produced on a calf must carry a larger proportion of the keep of a beef cow. On the other hand, gains on younger calves and steers require less feed than gains on older animals, so that the higher cost per hundred pounds of beef for the keep of breeding cattle is probably more than offset by economy of labor in growing feed. Taking all these influences together, it does not appear that the net change in labor required to produce beef has been very great.

Following beef in order of importance, comes the sheep enterprise. Since 1909 the total number of sheep in the country has fluctuated with relative prices and with feed supplies, but the total number of stock sheep in 1932–36 was 8 percent greater than in 1909–13, as shown in table 53 while production of mutton had increased 60 percent and wool nearly 30 percent.[5]

Increase in production per head of stock sheep, if under a constant set of conditions, involves also an increase in labor per head. Increase in number of sheep, however, has occurred in the western or range sections where labor per head is lowest. Consequently, it seems probable that whatever net change has occurred in labor on this enterprise also has been small.

[5] Data from Bureau of Agricultural Economics, for annual figures see WPA N. R. P. Report No. A–6, tables A–99, A–100, and A–101.

CHANGES IN LABOR REQUIREMENTS COMPARED WITH TRENDS IN FARM EMPLOYMENT

We are now in a position to see how far the changes in labor requirements estimated for the principal farm enterprises conform to the actual changes in agricultural employment for the country.

TABLE 53.—*Number of sheep, production of mutton and wool, specified periods*

Year	Stock sheep	Sheep and lamb production	Wool production
	Millions	*Mil. lbs.*	*Mil. lbs.*
1909–13	43.8	1,202	28.2
1917–21	36.4	1,116	24.6
1927–31	44.1	1,855	33.2
1932–36	47.3	1,923	36.4

TOTAL LABOR REQUIREMENTS ON PRINCIPAL ENTERPRISES

From 1909–13 to 1927–31, total labor required to grow the five major crops, corn, oats, wheat, cotton and potatoes, declined from 7,470 to 6,724 million man-hours per year (table 54). With the droughts of the early 1930's and with the AAA crop-control plans, there was a further decline to 5,575 million in 1932–36. In the meantime labor requirements on dairy cattle, chickens, and hogs increased from 3,816 to 5,159 million man-hours a year and labor on 15 truck crops from 200 to 394 million hours. Thus total labor on these 23 selected enterprises rose from 11.5 billion hours in 1909–13 to 11.9 billion in 1927–31, and then declined to 11.1 billion in 1932–36.

These estimates of labor requirements for the various enterprises were made very largely independently of each other. In each case, it should be pointed out that there was a considerable margin of possible error because of lack of data or inconclusive information, particularly for areas where the enterprises named were minor ones.

The five major crops comprised about 46 percent of the weighted agricultural production in 1924–29, while products of the three livestock enterprises amounted to 30 percent. The 15 truck crops add another 2 or 3 percent, bringing the coverage of aggregate farm production to between 75 percent and 80 percent. These figures do not cover farm overhead labor in care of buildings, fences, cutting weeds, etc., nor on horses, tractors, and other farm power units. Furthermore, there are many days when farm workers are not fully employed because of bad weather or other reasons, while part of the time actually worked goes to provide fuel for the household or is used for personal purposes not chargeable to the farm.

TABLE 54.—*Average annual labor requirements on principal agricultural enterprises for specified periods 1909–36*

FIVE MAJOR CROPS [2]

Year	United States [1]	Corn area	Eastern dairy area	Western dairy area	Middle Eastern area	Eastern cotton area	Delta cotton area	Western cotton area	Small grain area	Range area	Northwest area	California
	Mil. hours	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*	*Mil. hours*
1909–13	7,470	916	326	420	942	1,698	1,068	1,198	524	23	42	8
1917–21	7,184	894	308	430	957	1,518	1,031	1,175	490	41	41	16
1927–31	6,724	708	217	350	838	1,292	1,185	1,301	441	59	28	28
1932–36	5,575	669	207	342	727	1,028	938	884	404	52	23	35

FIFTEEN TRUCK CROPS [3]

1909–13	200											
1917–21	250	26	31	13	51	51	29	18	1	5	1	23
1927–31	340	30	38	17	56	61	34	27	1	18	6	55
1932–36	394	30	43	18	63	76	43	36	1	16	8	59

THREE LIVESTOCK ENTERPRISES [4]

1909–13	3,816	711	546	591	477	143	160	238	330	52	74	70
1917–21	4,387	789	557	770	541	165	176	262	407	75	102	90
1927–31	4,883	884	532	902	565	154	184	321	540	99	132	131
1932–36	5,159	902	551	967	613	171	216	372	529	99	141	121

TOTAL SELECTED ENTERPRISES

1909–13 [5]	11,486	1,627	872	1,011	1,419	1,841	1,228	1,436	854	75	116	78
1917–21	11,821	1,709	896	1,213	1,549	1,734	1,236	1,455	898	121	144	129
1927–31	11,947	1,621	787	1,269	1,459	1,507	1,403	1,649	982	176	166	214
1932–36	11,128	1,601	801	1,327	1,403	1,275	1,197	1,286	934	167	172	215

APPROXIMATE PERCENTAGE TOTAL WEIGHTED PRODUCTION IN SELECTED ENTERPRISES IN 1924–29 [6]—

	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Five major crops	46	39	20	22	47	76	74	69	38	17	10	5
Three livestock enterprises	30	38	49	52	31	9	12	14	35	21	35	27

[1] United States total includes 6 States not included in the areas named; that is, Maine, Rhode Island, New Jersey, Delaware, Florida and Missouri.

[2] Includes corn, oats, wheat, cotton, and potatoes for the United States, and for the areas in which these are major crops. Data from tables 35, 36, 37, 38, 39.

[3] Of the 15 vegetables, 14 were raised for market and 8 for manufacture. Data from WPA N. R. P. Report No. A–12, table 15.

[4] Includes labor on all dairy cattle, chickens, and hogs, based on tables 43, 44, 45. Hogs, however, are included in figures given for United States, and corn, western dairy, small grain, and middle eastern areas only. Available information was not adequate to prepare estimates of total labor on hogs for other areas. Data on poultry are for 1910, 1920, 1927–31 and 1932–36.

[5] Labor on truck crops is included in total for United States but not in area totals.

[6] Computed from data on production of crop and livestock products in WPA N. R. P. Report No. A–6, Appendix A, and from labor weight per unit of production, Ibid., table C–2, pp. 244–245. Since the weights consist of approximate number of hours per unit of product, these figures are proportional to amounts of labor spent in 1924–29 on the farm enterprises which produced crop or livestock products for market or for consumption on the farm.

Farm Employment Compared With Work on Main Enterprises

The amount of farm work spent on general upkeep probably is not far from a third of the total, and the labor on horses in 1927–31 was equal to about 9 percent of the labor on the "productive" enterprises.[6] Total labor on "productive" enterprises was thus around 60 percent of the total work done on the farms. Consequently, that fraction of all farm labor included in table 54 was not quite half of the total.

In 1927–31 the average total number of persons employed in agriculture was 11,232,000.[7] Of this total, nearly 3 million were located in the corn and dairy areas, where the number of hours worked per year is about 3,000. Nearly 5 million were in the cotton and small-grain areas, where there is less livestock to care for in winter and where the number of hours worked per year is between 2,000 and 2,500. Hours per year in other areas run between the figures for the dairy areas and those for the cotton and small-grain areas.[8]

Although data are not adequate to estimate the average number of man-hours per farm worker for the whole country, such an average must be nearer the figures for the southern and small-grain areas than for the dairy areas. If the 11.9 billion man-hours spent on the 23 selected enterprises constitute less than half of the labor spent in agriculture, the total must be something over 24 billions. Twenty-four billion hours is equal to about 2,200 hours actually spent in farm work annually for each worker. When it is recalled that no provision has been made, either in the "overhead" or the direct labor category, for labor spent in caring for tractors or automobiles, and that some time is worked by the farmer on personal projects such as cutting wood for fuel, etc., the totals in table 54 do not seem unreasonable.

Labor on the 23 selected enterprises in 1932–36 was about 3 percent less than before the war, while total farm employment was down 9 percent.

Why is there a difference in degree of contraction between total employment and amount of labor required on the principal enterprises? There are three principal reasons. (1) The number of horses and the labor required in their care declined much more than labor on the "productive" enterprises, that is, enterprises yielding products for sale or use by the farmer's family. The tractors and automobiles that replaced the horses require much less time for their maintenance. (2) The figures on labor requirements contain a larger proportion of the total labor spent on livestock than of labor on crops.[9]

Labor on livestock increased or remained constant, while that on crops was generally declining. (3) Increased labor requirements for livestock occur largely in the winter season, when farm workers are not fully employed, while the declines in labor requirements on crops refer to the growing season. Thus, the shifts in crops and livestock were largely complementary to each other and made for more complete utilization of the available labor supply.

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[6] Estimate based on production figures and numbers of horses shown in WPA N. R. P. Report No. A–6, Appendix A, and on hours per head or per unit of product in Appendix C of same report.

[7] WPA N. R. P. Report No. A–8, table 1.

[8] See ch. IV, pp. 35–53.

[9] See WPA N. R. P. Report A–9, p. 68.

Changes in Labor Requirements by Areas

Relative changes in labor requirements and in employment differed from one area to another. This depended on relative importance of crop and livestock enterprises, proportions of total crop and livestock production covered by the selected enterprises, and the degree of mechanization of the different areas. In the corn area, major crops included 39 percent of total agricultural production in 1927–31 and the three livestock enterprises included 38 percent. Changes in total farm employment in the area conformed more closely to requirements of crops than to total requirements. From per-war years to 1927–31, crop requirements declined nearly a fourth and total employment a fifth in spite of a 24 percent increase in labor needed by the three livestock enterprises. A large part of the increase in these livestock enterprises, however, was made possible by feed and labor released by the 40 percent reduction in horses.

In the eastern dairy area labor on crops contracted a third while that on livestock remained practically unchanged. Here, however, the livestock enterprises included 49 percent, and the crops listed only 20 percent of total farm production. Also the production of vegetable and other crops increased, so that employment declined only one-seventh. The developing western dairy area offers a contrast. With its expanding crop acreages, labor on principal crops fell only one-sixth, while requirements of the growing number of livestock rose a half. With an appreciable amount of mechanization, agricultural employment here remained practically unchanged.

Employment in the South conformed more closely to requirements on crops than on livestock, but the reasons for this differed from those which caused similar trends in the corn area. Livestock are relatively unimportant here, and cotton dominates the farm-employment situation. The five major crops account for 69 percent to 76 percent of production, while dairy and poultry products amount to only 9 per cent to 14 percent. Further, population movements and the boll weevil invasion caused greater declines in employment than in labor requirements in the delta and western cotton areas from 1909–13 to 1917–21, but greater declines in the eastern cotton area during the 1920's. During the 1930's, however, lack of industrial opportunities and the backing up of population on farms practically stopped the fall in farm employment even while crop production was being curtailed.

The small-grain area had a pronounced increase in total labor requirements for poultry and milk cows, while labor on major crops declined about one-sixth between the pre-war years and the end of the 1920's. Total labor requirements for crop and livestock enterprises combined was about one-sixth greater in the more recent years. With a reduced number of horses to care for and with but little change in numbers of beef cattle or sheep (which are not included in the figures in table 54) employment was about the same in the late 1920's as before the war.

The type of comparison made for areas discussed thus far hardly holds for the range and northwestern areas and California. The selected enterprises cover only a third to a half of total farm production in these areas. Other enterprises, such as fruit crops, range cattle, and sheep are also of great importance. Fruit production has in-

creased sharply while there has been only a little change in numbers and probably little in labor requirements of range livestock. The shift from horses to mechanical power, however, has been pronounced and has released considerable labor, particularly in the Pacific areas. Thus while estimated labor requirements doubled on the included major crops and livestock from 1909–13 to 1927–31, employment in these three areas increased only a fifth to a third.

Several conclusions may be drawn. (1) The crop and livestock enterprises selected for special study included about three-fourths of total weighted agricultural production of the country in the period 1927–31. The proportion was considerably less in the far western areas. (2) The sum-total of estimated labor requirements for these major products in 1927–31 is closely comparable to the estimates of total employment on farms. This is so, however, only if, in addition to direct labor, that needed in caring for farm power outfits, overhead labor, labor spent for personal uses, and losses in working time during slack seasons and inclement weather is considered. (3) While trends in estimated labor requirements on major products do not conform directly to trends in employment, they are consistent with these trends. To reconcile the two, the saving of labor in care of horses, and the shifting of labor from crops in the growing season to livestock in the winter must be taken into account. But again an exception must be made for far western areas where the enterprises studied covered less than half of the total agricultural production.

Comparison With Urban Industries

Trends of employment and of production differ strikingly between agriculture and the manufacturing industries.[10] From 1919–21 volume of production in agriculture increased 13 percent while employment remained practically unchanged. In eight groups of manufacturing industries which underwent relatively small increases in output per man-hour, the median volume of output increased about 5 percent and employment declined 6 percent. In eight manufacturing industries with a large improvement in labor efficiency, output increased 84 percent and employment rose 3 percent.

After the depression of the 1930's set in, agriculture lost relatively little of its working force, as a large proportion of the workers were farm operators and therefore self-employed, and as the farms were able to absorb part of their surplus population for a few years. Employment in agriculture declined only 2 percent from 1927–31 to 1932–36. Production in the same period fell by 9 percent, but the greater part of this decline is attributable to drought and the programs of the AAA rather than to a contraction in scope of operation. In the manufacturing industries mentioned above there was a very pronounced contraction. Even in those industries where output per man was increased most rapidly, production and employment each declined 5 percent, while in the eight industries with least increase in labor efficiency, production dropped 29 percent and employment fell 20 percent. In other words, in manufacturing industries unneeded workers are laid off during a depression, while in agriculture unneeded workers tend to stay on the farm until other opportunities open up.

[10] See Appendix for more complete discussion of the trends in urban industries as compared to those in agriculture.

CHAPTER IX. DEMAND FOR AGRICULTURAL PRODUCTS AND THE RELATION OF EXPORT TRADE TO EMPLOYMENT IN AGRICULTURE

Even though employment in agriculture has been reduced by improved methods during the last quarter century, the question may be raised whether expanding demands for agricultural products may offset this decline later. A closely related question is whether measures aimed primarily at stimulating employment in this field would find adequate demand for an enlarged agricultural output.

VOLUME OF PRODUCTION DEPENDS ON VALUE

Employment in an industry, at any particular stage of its technological development, depends on its volume of production. Volume of production, in turn, depends on values of the products; in other words, on the ratios at which the products of one industry exchange for those of another. This touches the demand for the product as well as its supply. The buying power of consumers is limited, and if they purchase one commodity there is, at any given moment, that much less purchasing power left to buy other things. This does not deny an element of elasticity in the time of purchase which is permitted by the exercise of consumers' credit.[1]

At any given moment, there is also a limited supply of some of the instruments of production. The blast furnace that is making steel for farm implements cannot at the same time make steel for construction of buildings or for use on railroads. This fact is most important when the resources in question are fully employed, whether they consist of land, of laborers, or of machinery. When a resource is partly idle there is less certainty as to how an industry will react to a given bid for its services. Under some circumstances almost any offer may induce it to go to work. In other cases, as when organized producers are attempting to preserve a certain price structure, or labor organizations are trying to maintain a certain level of wages, there may be reservation prices below which the resource will remain idle rather than go to work.

Over a moderately long period, however, it is still true that, in a free industry, values of products have a definite function of economic control. That is, they direct the use of resources into the channels where they are most wanted. There are various ways of accentuating or reducing the force of this control device or directing it into one channel rather than another. Some of these devices will be discussed later, insofar as they are concerned with the present problem.

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[1] Nor does it deny that an increase in output by one economic group may constitute an increase in demand for the product of other groups, as well as an added offer in exchange for products of the other industries. Whether the expanding industry can actually command more goods in exchange for its own product, however, depends on the elasticity of demand for its product. It may be that the increased output will buy less of goods and service in general than would a smaller output. In this case expansion of output would actually result in a smaller total remuneration for persons engaged in the industry as well as lower income for each individual. This subject will be discussed again a little later.

Value and Production Control Under Dynamic Conditions

Regardless of which industry is considered and whether the period of time is long or short, new enterprises and the expansion of old ones cannot be expected to occur unless anticipated values of the products equal or exceed the values of the cost factors required to organize and operate the producing plant. The values which are important here, however, are not necessarily those existing at the moment the plant is organized or when production is begun, but rather the values which are expected for the future, during the life period of the plant.

It is important that the relationships between values and volumes of production operate somewhat differently as between the long or "normal" period just described and a short period under dynamic conditions. Once an investment has been made and purchasing power has been exchanged for physical, capital goods, the important question is not what the past cost has been, but rather which of the available alternatives in use promises the greatest future return; and there is no rational connection between that use and either the costs or the expectations of the past.

The practical application of this principle is that, in plants already established, continued use of the resources may be expected until they wear out or become economically obsolete. In fact, such use will be in the interest of the owner, as long as it yields any returns over the current expenses of operation. The relationship between present costs and present values is of consequence only insofar as it affects the establishment of new plants or the renewal of old resources which are wearing out.

High Fixed Costs in Agriculture

In agriculture a large proportion of the costs are concerned with the use of long-lived resources such as buildings, machinery, and even land. Flexibility in volume of production, and therefore in employment, is relatively limited. This may be illustrated by data from 166 prosperous farms in Southeastern Minnesota for 1937.[2] With average total receipts of $6,393 on these farms, $3,025, or approximately half, was spent for operating expenses that vary rather closely with the volume of production. Taxes, insurance, and the maintenance of permanent improvements took $600, although 1937 saw larger outlays than usual for this purpose. The balance of $2,752 had to cover the labor of the farm operator and members of his family and also returns on the use of his land and capital. The latter was estimated at 5 percent on the valuation of the combined land and capital and amounted to $1,036, leaving $1,716 as remuneration for about 18 months of family labor.[3]

Values of Resources Largely Determined by Earnings From Their Use

Suppose, however, that earnings on investments in land and buildings had run for a period of years at a figure below $1,036. In time it is certain that the valuation on these resources would have been

[2] From University of Minnesota, Division of Agricultural Economics, Mimeographed Report No. 96, p. 6, *Annual Report of the Farm Management Service for Farmers in Southeastern Minnesota, 1937.*

[3] Obviously, these were relatively successful farmers. Many did not earn as much as 5 percent on the appraised valuation of their land and capital, or current wages for their labor, even in the favorable year 1937.

reduced, particularly if there were other investments in which a rate of 5 percent could be obtained. In other words, the valuation of these resources depends on the earnings that are received from them.

A large part of the input into operation of a farm consists of resources which are owned by the farmer himself and which he must ordinarily continue to use whether he receives a large or a small return from them. Among these may be mentioned the farmer's labor and that of members of his family. It is altogether unrealistic to say that they must receive some certain remuneration for their labor and that failing in this they will or should cease to farm. Actually the choice is generally between operating the farm and receiving some return for the use of their labor and other resources, or disposing of the farm entirely and looking for something else to do. Further, at those times when returns from the farm are smallest, opportunities of selling the farm and finding other jobs are usually worst.

Earnings must be extremely low in agriculture to induce a farmer who is already established to give up his experience and forego the possibility of future improvement in farm values in order to transfer his labor to some other industry.

As far as the farm itself is concerned, very little liquidation is possible except through the slow process of deterioration of improvements and depletion of soil. Sale of the farm does not evade this fact, since it involves merely the transfer to someone else of ownership of the land and of whatever returns can be obtained from it. If these are low, the rental rate and the price of the land is usually affected more than the volume of production on it. Thus rent, which is the expense involved in the use of the land, is determined by the price of the product, not the price of the product by any necessary rate of rent. Furthermore, the same statement can be made of the "costs" of old capital goods and of the operator's labor during moderately short periods of time.

On closer examination these price-determined costs prove to be merely competitive bids for the use of the resources in question. The amount of the bids, that is the level of the costs, is determined by the intensity of demand for whatever supply of a production factor is available. This in turn rests on the intensity of demand for the product to which it contributes, which intensity declines as the size of the supply increases. Thus, if a larger amount of labor, for instance, be applied to the production of wheat or corn, the expansion of output soon encounters a resistance on the demand side in the form of lower price for the product. On the production or cost side there are also resistances to the expansion of output, particularly in agriculture.

Application of Principle of Diminishing Returns

As any one of the factors of production becomes relatively scarce there is a tendency to make more intensive use of it. Thus, as land becomes more scarce, it is profitable to apply more labor and capital per acre, but after this intensification has proceeded to a certain degree, additional days of labor or dollars of capital bring smaller and smaller increases in output per unit applied.

It may be taken for granted that if population grows enough a greater amount of product can be disposed of without a lowering of

price and also that more employment will be provided as population grows. But with the growth of population the number of persons seeking employment also increases.

With a given size of population and a given array of demands per capita for farm products, any expansion in the volume of farm production, such as would result from increased application of labor on farms, would soon encounter economic resistances from both of the directions just mentioned (unless the increased labor were applied in an altogether unproductive way). The added units of labor might be expected to lead to a less than proportionate increase in the output. The increase in output that did occur would encounter a lower intensity of demand and consequently lower returns per unit than for the previous and smaller supply. Thus, larger returns per hour of labor imply smaller employment; and larger employment implies a smaller return per hour of labor, unless some more or less artificial means is found of preventing the usual operation of the principles just described.

Means of Stimulating Production and Employment

Economic resistances can be either overcome or evaded in various ways provided someone is willing to bear the expense of doing so. One of these ways would be by direct subsidy to the producers since this in effect permits production at higher cost or sale at lower price or a combination of the two. Another that may be effective for a time is by withholding enough of the product from the market so that the price of the enlarged output does not actually decline. Still another possibility might be to withdraw part of the land (or part of some other essential resource) from use, so that it becomes necessary to use labor under less advantageous circumstances, and therefore to use more labor to produce the same amount. Employment in agriculture or any other industry could be increased artificially by various other means, but in one way or another it is necessary for such an industry: (1) to shift part of the wage bill to some one other than the producer, (2) to remunerate him to some extent by other means than the free market price, (3) to restrict the use of some other resource, so that it can be replaced by labor, or (4) to employ the added labor at a lower wage.

If the more positive means of stimulating employment, and consequently, production, were to be used, it would be important to know in advance how severe the resistances to expansion would be. To anticipate the cost of the program, and its ultimate chances of success, information would be needed as to capital outlay and costs of operation where expansion is to occur. For instance, it is not probable that capital and operating costs per unit of product would be lower in newly settled or in more intensively farmed areas than in those which are already producing. And if such costs ruled generally higher and returns lower than among present farmers, we might soon expect to see the new farmers drifting into other industries where remuneration is higher, unless the difference is made up in some other way.

This is on the assumption that other employment is available. If in fact the labor or any other resource is not already fully employed, and if the choice is between employment at a lower than standard rate

of return or no employment at all, it may be that a relatively low rate would be enough to maintain for some time the expanded volume of production and of employment. But it is not to be expected in the latter case that there would be no reflex shift in employment at all from the expanded industry to others. There are always capable individuals to whom opportunities are open elsewhere than in the industry where they are employed, and the movement of these would certainly be accelerated by any influx of new workers or of new capital which increases production and thereby lowers the remuneration of those already in the industry.

Moreover, if stimulation in one segment of the industry were not soon to result in contraction elsewhere, it would be necessary either to find outlet for the expanded output without a lowering of prices, or to provide supplementary remuneration to offset the fall of prices resulting from lower intensity of demand. This raises the question, How much does the intensity of demand decline if the output of farm products is increased without corresponding increase in population? In other words, what is the elasticity of demand for farm products?

ELASTICITY OF DEMAND AS RELATED TO FARM EMPLOYMENT AND REMUNERATION

By elasticity of demand is meant the rate at which quantities of a commodity bought change in response to a change in price. Elasticity of demand for farm products is highly important in this discussion, as it indicates inversely the change in price that is necessary to induce consumers to purchase additional amounts of product.

While existing statistics on elasticity leave much to be desired, it is apparent that, for most farm products, it is less than unity. That is, a 1 percent fall in price per unit brings about less than a 1 percent increase in quantity bought.[4]

As an example of a measure of elasticity, it has been stated that the elasticity of demand for corn is approximately -0.6, and that for hogs slightly less than -0.6.[5] This means that in response to a 1 percent fall in price the quantity of one of these commodities bought would increase only 0.6 percent. A corn crop 106 percent of normal might be expected to yield a price only 90 percent as great as normal, so that the total income from sale of the crop would be only (1.06×0.90) or 95 percent of the normal income. It appears probable that demand for other major agricultural commodities which have been studied in the recent past may be even less elastic.

The elasticities of demand mentioned relate only to individual products. Very little is known about the probable response of consumers to increased or decreased supplies of all farm products combined. Thus the fact that a 1 percent decline in price is necessary in order to induce consumers to take an added half, or two-thirds of 1 percent of pork, gives no indication as to what price decline would be required

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[4] Because of the many and involved manipulations to which it is necessary to subject market prices in order to correct for price levels, and for various other disturbing influences, there is doubt as to the statistical validity and significance of the measures of elasticity found.

[5] Geoffrey Shepherd and Walter W. Wilcox. *Stabilizing Corn Supplies by Storage.* Iowa Agr. Expt. Sta. Bul. 368, December 1937, pp. 336–343.

to dispose of the same proportionate increase in supply of all meat products together, much less in all food products. Since a large part of the elasticity of demand for individual commodities is explained by the ease or difficulty of substituting one commodity for another within the same class, it is safe to conclude that demand for the commodity-class as a whole is much less elastic than for the individual commodities taken one at a time.

For present purposes the degrees of elasticity which have been used for illustration provide useful guidance: (1) They understate rather than overstate the price reaction to be expected from a given change in the total output of all farm products combined; (2) it is the wholesale rather than the retail demand schedule with which the farmer comes in contact, and the price reactions to be expected in the wholesale market are relatively greater than in the retail market.[6]

Inelasticity of wholesale demand schedules for farm products constitutes a very serious resistance to any measures intended to enlarge employment in agriculture more rapidly than is permitted by the growth of population or the development of new uses for farm products. As with inelastic demand, large crops bring in smaller gross returns than smaller ones, such measures could be expected to reduce returns both per worker and to the industry as a whole. Further, this shrinkage of remuneration would be suffered not only by the new workers but by the old ones as well. Thus any expansion of agricultural output which *could afford increased employment at current levels of remuneration*, must depend on an increase in the capacity of the country to consume such products. What have been the recent trends in per capita consumption of principal farm products?

CHANGES IN CONSUMING HABITS

An ever present threat which hangs over the worker in agriculture as well as in other industries, is that the consuming public may change its preference and shift to other products. This may not seem a very serious threat when food products are taken as a group. The need for human food is relatively inelastic for any given nation, with its background of rather rigid habits of eating. A little investigation, however, will show that American food habits have not been so rigid as to prevent pronounced declines in the use of some foods and counterbalancing increases in others.

As types of food shift, a change may occur in the amount of labor needed to feed a given population. Thus, much more labor is needed to produce a pound of human food in the form of meat or milk than of bread or corn for direct consumption. Between 4 and 5 pounds of grain are needed to produce a pound of gain on a hog and 8 or 9 pounds of grain plus roughage to produce a pound of live steer. Further, the dressed weight of the hog is slightly less than 80

[6] Transportation and processing margins change relatively little as between large and small crops. Consequently the greater part of the price change necessary to uncover the additional demand needed to absorb a larger crop must be borne by the farmer. Thus the wholesale demand must be less elastic than the retail demand, which is to say that wholesale prices must fluctuate by the larger percentages. Further, as we move to lower price levels, an approximately constant processing margin becomes a larger percentage of the retail price, so that wholesale demand becomes increasingly inelastic at the lower levels. (See Appendix E, filed in the Library of the Bureau of Agricultural Economics, for further discussion.)

percent of the live hog, while the steer loses nearly half in dressing. The dairy cow produces milk at a much higher physical efficiency than the steer can produce meat. But even she yields, in her milk, only slightly over one-fourth of the digestible nutrients which she consumed in feed.[7]

In the production of green vegetables or fruits more labor is generally needed for a given number of calories of human energy than if such energy is obtained from cereals. It is true that milk, meats, green vegetables, and fruits are richer in certain vitamins, mineral elements, and so on, than are some of the cheaper food products like cereals or potatoes. Still, the more appetizing and healthful diet containing an abundance of milk, green vegetables, and fruits requires more labor to produce than does the cheapest diet capable of yielding the same amount of human energy. It has often been observed that persons in the higher income brackets consume more of the more desirable, and incidentally more expensive, foods and that there is a tendency for demand for select foods to increase during periods of full employment and prosperous business.

Changes in Consumption and Trends in Demand

Shifts in food consumption are not so simple and direct as might be supposed from the above paragraph. Changes in volume of consumption should not be confused with changes in consumer preference, although the two may be closely related. Over a period of several years, mechanization and improved technology have not lowered production costs of all farm products equally. Some shifts in consumption have been stimulated by technological changes. But there have also been shifts in consumer preference which are more difficult to explain.

Changes in Food Consumption Since 1910

About 92 percent of the total crop acreage in the United States during the last decade has been used to produce food products and the rest for various nonfood crops such as cotton, tobacco, flax, etc. The crop acreage per capita of total population declined from 2.61 acres in 1909–13 to 2.40 acres in 1927–31, and to 2.15 acres in 1932–36 when acreages were curtailed by the AAA programs.[8] Most of this decline before 1932–36 is attributable to the reduction in work stock used in growing the crops (table 55). Acreage in food crops per capita has changed much less than the total. Within this total, however, there have been some notable shifts between crops and types of products.

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[7] F. B. Morrison, *Feeds and Feeding* (20th ed. Unabridged; Ithaca, N. Y., Morrison Pub. Co. 1936), p. 478.

[8] A valuable summary of the principal trends in consumption of farm products is to be found in pt. III of the Supplementary Report of the Land Planning Committee to the National Resources Board, 1935, prepared by Dr. Norman S. Gold.

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TABLE 55.—*Acres in crops per capita, 1909–38* [1]

Crop year	Major food crops	Major non-food crops	Work stock	Total crop
	Acres	*Acres*	*Acres*	*Acres*
1909–13	1.87	0.17	0.57	2.61
1917–21	1.77	.17	.50	2.44
1922–26	1.89	.18	.47	2.54
1927–31	1.83	.16	.41	2.40
1932–36	1.66	.16	.33	2.15
1937–38	1.82	.16	.33	2.31

[1] Data from Bureau of Agricultural Economics, constituting an extension and revision of table 1, p. 3. *Agricultural Land Requirements and Resources*, pt. III of Supplementary Report of the Land Planning Committee to the National Resources Board, Washington, 1935.

Principal changes in consumption of foods have been a decline in direct consumption of cereals, an increase in sugar and some increase in livestock products (table 56). The per capita consumption of cereals declined around 25 percent during the war and has fallen further since 1929. The greatest decline was in direct consumption of corn for human food which fell about half from the pre-war period to 1933. Consumption of sugar partly offset the reduction in cereals by an increase of between 20 percent and 25 percent from 1915 to 1921 and a somewhat further rise by 1925.

Production and consequently consumption of livestock and livestock products varies from year to year with the size of feed crops and the outlook for prices of livestock products. With the contraction of the range area since 1909 there has been a decline in production (and therefore in consumption) of beef and sheep. At the same time, production of hogs, partly on feed crops raised in these same western areas, has increased. From decade to decade, however, total meat production has changed very little.

The largest changes in consumption of livestock products have occurred in milk and dairy products and in poultry and eggs. Improved methods of production, and their spread into new areas increased the output of these foods at a time when discoveries in the principles of nutrition were causing increases in their demand. Per capita consumption of milk and its products increased about 7 percent from 1910 to 1930, and consumption of eggs and poultry products rose by a quarter (table 57).

One of the most pronounced changes in food consumption has consisted of a sharp increase in the use of leafy, green, and yellow vegetables. Consumption of lettuce, celery, asparagus, and carrots has at least doubled since 1919–20 and total consumption of vegetables other than potatoes has risen at least a quarter. At the same time there has been a corresponding decline in the use of potatoes.

Studies of human diet have led to placing more emphasis on the use of milk, eggs, green vegetables, and fruits, particularly citrus fruits. These are considered more palatable than the cheaper and coarser cereals and vegetables and there is a trend toward their consumption rather than that of meats by an increasingly sedentary population. It is not unreasonable to expect that the trends of the next several years are likely to be somewhat of a continuation of those of the last quarter of a century.

TABLE 56.—*Changes in per capita consumption of selected groups of foods for specified periods 1909–37* [1]

(PERCENTAGES OF 1922–23 TO 1926–27 AVERAGE)

Crop year	Cereals [1]	Sugar [2]	Non-citrus fruits [3]	Citrus fruits [2]	Potatoes [4]	Fresh vegetables [5]
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1909–13	132	78	104	65		
1917–21	102	84	91	71	100	92
1922–26	100	100	100	100	100	100
1927–31	97	100	95	117	98	106
1932–36	88	94	88	139	92	116
1937–38	86	95	102	203	98	132
ANNUAL POUNDS PER CAPITA						
1932–36	*Pounds* 198	*Pounds* 96	*Pounds* 163	*Pounds* 41	*Pounds* 152	*Pounds* 152

[1] Data from 1909–10 to 1921–22 derived from *Report of the Land Planning Committee, 1935*, to the U. S. National Resources Board, pt. III, table III; data from 1922–23 to 1938–39 provided by the Bureau of Agricultural Economics.

[2] Data for calendar years beginning 1909 source: 1909–21, National Resources Board, *ibid.*, table V; 1922–38, Bureau of Agricultural Economics.

[3] Data for 1909–10 to 1921–22 from National Resources Board, *ibid.*, table IV. Data from 1922–23 to 1938–39 from Bureau of Agricultural Economics.

[4] Data provided by Bureau of Agricultural Economics.

[5] Includes canned vegetables in terms of fresh. Data from Bureau of Agricultural Economics.

At the same time the average age of the population is increasing and the number of children to be fed per thousand persons is declining. This means that there will be some offsetting decline in the proportion of milk and eggs from decade to decade for the next 20 or 30 years. Of the two opposing influences this appears to be of the smaller magnitude, and the prospects are that there will be some further increase in labor cost of the national diet, insofar as the population is able to afford the more healthful and, incidentally, more costly foods.

TABLE 57.—*Per capita consumption of dairy and meat products, for specified periods, 1909–37*

Crop year	Dairy and milk products	Beef [1]	Veal [1]	Lamb and mutton [1]	Pork [1]	Lard [1]
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1909–13	[2] [3] 759	68.4	7.0	7.1	66.5	11.8
1917–21	[2] 779	62.3	7.6	5.3	62.7	11.4
1922–26	[2] 792	59.9	8.3	5.3	69.4	12.5
1927–31	[4] 816	50.0	6.6	6.0	68.9	13.1
1932–36	[4] 809	52.8	7.6	6.7	61.6	12.4
1937–38 [5]	[5] 809	54.2	7.9	6.8	56.1	10.9

[1] Source: *Livestock, Meats, and Wool Market Statistics and Related Data, 1937* (U. S. Dept. of Agr., Bur. Agr. Econ., May 1938), p. 81.

[2] *Report of the Land Planning Committee, 1935* to the U. S. National Resources Board (pt. III, table III).

[3] 1910–13 average.

[4] *Agricultural Statistics, 1938* (U. S. Dept. Agr., 1938), p. 346.

[5] Estimate of Bureau Agricultural Economics.

Development of Synthetic Fibers

It was said above that about 92 percent of the farm acreage during the last decade was used to produce food products. Most of the remainder is used for textile fibers. Whatever affects the demand for these fibers is a matter of consequence to about 2 million cotton growers and to 600,000 sheep producers.

One of the most spectacular developments affecting the demand for farm products has been in the production of synthetic fibers (table 58). Practically all of this growth, insofar as its economic effects are concerned, has occurred in the last 20 years.

Table 58.—*United States consumption of principal textile fibers, for specified periods, 1910–38*

Year	Cotton—domestic consumption [1]	Rayon yarn [2]	Silk—raw imports [3]	Wool—scoured basis [4]
	1,000 bales	*Million lbs.*	*Million lbs.*	*Million lbs.*
1909–13	5,062	[5] 3	23	----------
1917–21	5,311	10	38	[6] 346
1922–26	6,437	44	56	373
1927–31	6,032	121	79	326
1932–36	6,300	219	65	313
1937–38	6,303	290	56	320

[1] Harvey J. Zimmerman, *Cotton Production and Distribution, Season of 1937–38* (U. S. Dept. Com., Bur. Census Bul. 175), p. 23, excluding linters. Data are for years beginning Sept. 1, in 1909–13, and Aug. 1, from 1917–37.

[2] *Rayon Organon* (New York: Textile Economics Bur., Inc., monthly publication). Data for 1911–34 from January 1937 issue, p. 16. Data for 1935–38 from supplement, Jan. 23, 1939, p. 16.

[3] Data furnished by U. S. Dept. Com., Bur. of Foreign and Domestic Commerce.

[4] *Raw Wool Consumption Reports* (U. S. Dept. Com., Bur. Census, Feb. 29, 1936, Jan. 30, 1937, Jan. 31, 1939).

[5] Average for 1911–13.

[6] Average for 1918–21.

The evolution of rayon is of special interest. For one thing the new industry is largely located in areas where previously a considerable amount of labor was not very highly utilized.[9] Also, it suggests some of the many industrial shifts that may result from a new product.

In 1921 the output of rayon, then considered a substitute for silk, amounted to less than 1 percent by weight of the total consumption of textile fibers in the United States. The price was $2.69 per pound as compared to $6.57 for raw silk and was far above a level at which it could compete either with wool or cotton. By 1937 both production and consumption of rayon had increased until it amounted to about 9 percent of all textile fibers used, and the price of rayon yarn had declined 62 cents per pound (table 59).

[9] A map in the *Rayon and Synthetic Yarn Handbook*, 1st edition, 1934, p. 63, shows rayon plants to be located chiefly from Manchester, N. H., to Rome, Ga. But the most and the largest are in the eastern edge of the mountains, from Lewisville, Pa., to Old Hickory, Tenn., and Asheville, N. C. The author of this chapter of the Handbook attributes their location to an abundance of good water and to nearness to markets. But it is highly significant that this is also an area of surplus labor, which was available for the establishment of the new industry.

TABLE 59.—*Prices of principal textile fibers, 1910–38*

Year	Cotton, upland middling New York,[1] per pound	Rayon yarn[2], 150 deniers	Silk, raw[1] Japan, 78 percent white 13–15 at New York	Wool, Ohio, medium grades, scoured basis at Boston[3]
	Cents	*Dollars*	*Dollars*	*Dollars*
1910–13	13.1	[4] 1.85	4.02	0.48
1917–21	27.4	4.13	7.70	1.16
1922–26	24.0	2.32	7.06	1.01
1927–31	15.7	1.11	4.25	.80
1932–36	10.3	.60	1.57	.63
1937–38	10.0	.57	1.80	.73

[1] Source: Data furnished by Wholesale Price Division of U. S. Bureau of Labor Statistics.
[2] *Rayon Organon* (New York: Textile Economics Bur., Inc., monthly publication). Data for 1911–34 from issue of January 1937, pp. 24–5; 1935–38 from supplement, Jan. 23, 1939, p. 25.
[3] Source: Derived from data furnished by Wholesale Price Division of U. S. Bureau of Labor Statistics; prices for 1910–12 were on scoured basis, other years were converted to a scoured basis by taking two pounds of unwashed wool as equal to one pound scoured.
[4] Average for 1910–13.

Competition is not confined to a price basis nor limited to products for which direct substitution can be made. An important development during the 1920's and later was that of inexpensive fabrics in which wool or cotton was mixed with rayon to achieve an effect different from that of the pure fabrics, and permitting the development of new and different types of textiles. About 1932 or 1933 spun rayon began to appear on the market. This is a short-staple rayon fiber which is twisted or spun. It can be given something of the appearance of wool and also something of its warmth. The production of spun rayon increased from 7 million pounds in 1935 to 25 million pounds in 1936 and to about 47 million pounds in 1937.[10]

Spun rayon has a much greater tensile strength than the original yarn, and is now being adapted to various industrial uses. One of the more interesting of these is its use to replace cotton in heavy-duty automobile and truck tires. Here the rayon is said to be more satisfactory than cotton because the smoother fibers cause less internal heating of the tires and give longer wear. In this use rayon becomes a direct competitor of cotton,[11] not because of lower price but because of superior service.

ARTIFICIAL WOOL FROM CASEIN

Another recent development, starting in Italy, is the production of an artificial fiber, similar to rayon, from casein, which is extracted from skimmed milk. This fiber, called "lanital" or artificial wool, is highly similar to wool in its chemical composition, but is reported to be considerably lacking in tensile strength and consequently in wearing quality.[12]

During the last 20 years the industries producing synthetic fibers have been changing rapidly, both in volume and type of product. Potential developments, such as that of lanital, make it hazardous

[10] "Textile World," 87(10): 89–96. September 1937.
[11] Harold DeWitt Smith, *Rayon Manufacture*, "Textile World," 87 (10): 104–105, September 1937.
[12] H. C. Borgetty, *Lanital, the Artificial Wool made from Casein*, "American Dyestuff Reporter," vol. 25, Oct. 5, 1936. Werner von Bergen, *Casein Wool*, "Rayon and Melliand Journal," 17: 75–76, January 1936.

to forecast trends for the future. Still another potentially important change may come from nylon, a synthetic silk substitute which is said to possess advantages even over silk for some purposes.

Industrial developments in other fields may also force further adjustments in agriculture. For instance, there is a possibility that the use of alcohol for motor fuel may become important at some future time. Alcohol has certain advantages for blending with gasoline because of its antiknock property. This advantage may be increased by the trend toward high-compression types of engines. Under the prices of 1940, the production of alcohol for fuel is decidedly uneconomic, but under a somewhat different set of economic conditions, and with some further change in motor design, it might furnish an important outlet for grain, sweetpotatoes, byproduct molasses, or other farm products.

CHANGES IN EXPORT TRADE AS AFFECTING EMPLOYMENT IN AGRICULTURE

One important influence on employment in agriculture is found in our changing export trade (table 60). Until the early 1920's exports of farm products exceeded imports regularly. In 1922 agricultural imports exceeded exports for the first time, and since 1925 this has been true each year. Further examination of the figures on imports, however, show that the greater part consists of things that could not be grown economically in the United States. The most important are raw silk, rubber, coffee, tea, sugar, and vegetable oils and oilseeds not produced in this country. On the other hand, several of our most important farm products are still exported in considerable quantities. Among these may be mentioned cotton, tobacco, wheat, pork, lard, and in recent years, increasing amounts of fruit. All parts of our agricultural economy are touched by this trade; some areas by providing the specific products for export and others, indirectly, by production of the same or competing crops for domestic consumption.

The precise amount of employment provided or supported by the export trade would be very hard to determine. Gross income from farm production in the United States for the years 1934 and 1935 is given by the Bureau of Agricultural Economics as 7.3 and 8.5 billion dollars, respectively.[13] Domestic exports of agricultural products for these years are given as 669 and 766 million dollars. Gross farm income figures, however, rest on valuations at the farm, while the exports are valued at the points of export and, therefore, at higher prices per unit. Further, it is not possible to tell just where all the exported products come from, and as has been demonstrated several times, the amount of labor used per unit of farm product varies widely between areas.

A stoppage of the export trade might not cause production to cease and unemployment to result in the specific area from which exports occur. If labor and other costs were low in the exporting area, it might continue to produce while farmers somewhere else were forced to curtail production. Such a reduction of exports might ultimately cause a greater total decline in employment than

[13] *Agricultural Statistics, 1938*, pp. 430, 384.

the amount of labor actually spent on the specific crops exported, but the decline would ultimately occur in nonexporting areas. It is not possible to tell just where or to what degree such reactions would occur. The estimates which follow are based on labor requirements per bushel, per bale, or per pound in the areas from which the exports actually come—as far as that can be determined.

TABLE 60.—*New exports of principal farm products and approximate annual amounts of labor used in their production, for indicated years, 1909–38*

Product	Unit	1909–13	1917–21	1922–26	1927–31	1932–36	1937–38
Quantities exported:							
Cotton [1]	1,000 bales	8,603	5,494	7,366	7,648	6,607	4,590
Tobacco [2]	1,000,000 lb	339	444	436	464	357	395
Hog products [3]	do	1,217	2,470	1,946	1,266	528	206
Wheat [4]	1,000,000 bu	105	235	178	142	[5] 1	105
Corn [6]	do	26	69	26	15	[5] 29	68
Apples [7]	1,000 bu	[8] 11,746	[9] 6,046	15,669	21,267	16,014	15,638
Prunes, dried [10]	1,000 lb	[11] 87	75	143	243	184	219
Raisins [10]	do	[11] 21	60	112	158	104	147
Apricots, dried [10]	do	[8] 26	16	20	26	28	32
Oranges [12]	1,000 boxes	[11] 1,273	[9] 1,719	2,588	3,671	3,740	6,695
Grapes [13]	Tons		[14] 9,145	4,955	19,472	12,797	29,168
Peaches [15]	1,000 bu		[9] 830	2,411	2,907	2,460	2,624
Pears [16]	do			2,421	3,706	4,807	5,003
Apricots, canned [17]	1,000,000 lb			[18] 31	26	21	30
Grapefruit [19]	1,000 boxes			236	904	829	1,090
Farm labor to produce exports:							
Cotton	1,000,000 hr. [20]	2,228	1,390	1,731	1,660	1,335	927
Tobacco	do	136	178	175	185	143	158
Hog products, direct labor		30	62	49	32	13	5
Raising feed [21]		62	116	89	56	22	8
Wheat	1,000,000 hr. [20]	82	150	89	52	([22])	33
Corn	do	15	37	14	8	([22])	33
Five principal fruits [23]	do	21	16	33	47	36	39
Total, 10 products	do	2,574	1,949	2,180	2,040	1,559	1,203
Grapes and peaches	do		1	2	3	2	3
Pears, canned apricots, grapefruit	do			4	6	7	8

[1] Years beginning August; total exports (domestic plus foreign) minus imports; bales of 500 pounds gross weight; linters excluded from 1914 to 1938.

[2] Net exports, years beginning July.

[3] Weight in live hog equivalents, that is, dressed pork x 1.33. Does not include re-exports. Imports designated as "General Imports" for 1915–20 and 1929–33 and as "Imports for Consumption" for 1909–14 and 1921–28. Includes bacon, hams, shoulders, Cumberland and Wiltshire sides, canned pork, fresh pork, salted and pickled pork, lard, sausage and sausage meat, plus or minus net exports or imports of live hogs counted at 225 pounds per head.

[4] Total exports (domestic plus foreign) minus total imports; beginning 1933 net exports are domestic exports minus imports for consumption; includes flour; years beginning July.

[5] Net imports.

[6] Years beginning October.

[7] Total exports (domestic plus foreign) minus imports; beginning 1933–34 domestic exports minus imports for consumption; years beginning July; includes dried, canned and fresh apples in terms of fresh.

[8] July 1912–June 1914.

[9] July 1919–June 1922.

[10] Total exports, dry basis; years beginning July.

[11] July 1911–June 1914.

[12] Net exports; years beginning October.

[13] Total exports (domestic plus foreign) minus imports; beginning 1933–34 domestic exports minus imports for consumption, years begin July.

[14] Net imports July 1919–June 1922.

[15] Domestic exports; years beginning July; dried peaches converted to terms of fresh at rate of 19 pounds dried to 100 pounds fresh; canned peaches at rate of 1 pound per pound fresh; 48 pounds fresh equals 1 bushel.

[16] Domestic exports; years beginning July; includes canned pears converted to fresh at rate of 85.5 percent of fresh weight, dried pears at rate of 5.5 pounds fresh per pound dried, 50 pounds fresh equals 1 bushel.

[17] Total exports, years beginning July.

[18] July 1923–June 1927.

[19] Net imports; years beginning September.

[20] For estimated labor requirements per unit see table 63, p. 182.

[21] Covers grain for hogs only; converted into terms of corn at the following rates per hundredweight of live hogs exported: 1909–13, 9.0 bushels; 1917–21, 8.7 bushels; 1922–26, 8.6 bushels; 1927–31, 8.5 bushels; 1932–38, 8.4 bushels; amounts of grain used to produce 100 pounds hogs estimated from various agricultural experiment station publications; labor per bushel used in raising the corn, same as shown in Appendix table F-1.

[22] Labor equivalent of net corn imports, 1932–36 disregarded since these imports were very largely attributable to drought and did not represent a proportionate reduction in farm employment in United States.

[23] Apples, prunes, raisins, dried apricots, and oranges.

Source of data: Exports of pork 1907–36 from *Livestock, Meat and Wool Market Statistics and Related Data, 1937*, U. S. Department of Agriculture, May 1937, figures on other exports from 1909 to 1936 from *Agricultural Statistics*, 1938, pp. 9–10, 38, 42–3, 94–5, 136–7, 147, 175, 190, 200, 203, 387. Exports for 1937–38 from *Foreign Crops and Markets*, U. S. Department of Agriculture, vol. 39, No. 20, November 10, 1939.

Sources and Land Requirements of Agricultural Exports

It was estimated by the National Resources Board that, during the period 1925–26 to 1929–30 about 63 million acres were used to produce farm products for export.[14] Of this, 47 percent was in cotton and 26 percent in wheat. With the depression of the 1930's and the growth of barriers to international trade, agricultural exports declined until they required only 39 million acres in 1933–34. This decline was equal to nearly 7 percent of the total crop acreage.

Though it is not possible to trace all exported crops to their original source, it is fairly well known where most of them come from. Most of the exported cotton comes from Texas and Oklahoma, though some is also shipped abroad from the Delta States. Wheat is exported from the hard red winter wheat States of Kansas, Oklahoma, and Texas, but some comes also from farther north, particularly from the Pacific Northwest. Tobacco is exported chiefly from the middle eastern area, though some is exported from Georgia and elsewhere. Exported pork originates chiefly in the corn area. Apples are exported from the northwest and also from some eastern sections, particularly from the Shenandoah Valley; dried prunes chiefly from Oregon; other dried fruits from California, canned fruits from California, oranges from California and Florida, and grapefruit from Texas. Thus most of the leading agricultural areas of the country are affected directly by this trade, and others indirectly through competition with the exporting regions.

Trends in the quantities of principal farm exports are shown in figure 27. From 1910 until 1918 total quantities of such exports increased about a half and then declined 10 percent or 15 percent to a new level which was held from 1923 to 1938. After this, exports fell sharply until, in 1936, they were only about half as great as during either the 1920's or the years just before the war.

Not all exports changed together. During the war years cotton exports declined by nearly a half while exports of foods more than doubled. Following the war, cotton exports recovered and food exports contracted as European nations became relatively self-supporting again. Exports of fruits, on the other hand, changed but little from the pre-war level until after 1921 and then trebled by the late 1920's, showing that habits of diet were changing abroad as well as in the United States.

Labor Requirements of Agricultural Exports

Cotton has been by far the most important agricultural export insofar as it has provided employment on American farms. The amount of cotton shipped out of the country required 2.2 billion man-hours a year in the period just before the war, and 1.7 billion during the 1920's. As the average number of hours worked per man on Southern farms is probably between 2,000 and 2,500 per year (ch. III) the annual production of cotton exports during the pre-war period required between 800 thousand and 1 million man-years of

[14] National Resources Board, Report of the Land Planning Committee, pt. II, 1935, pp. 117–121.

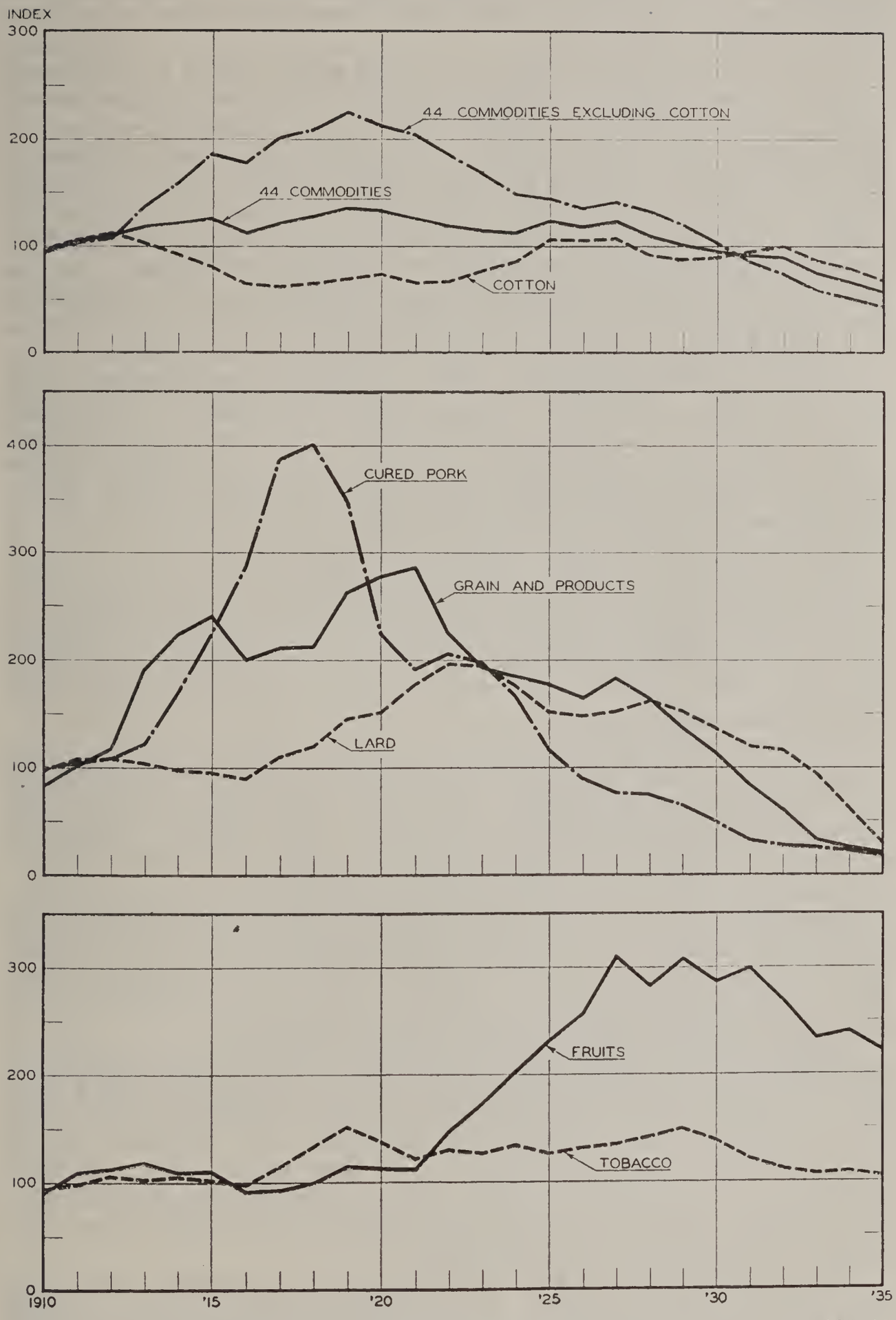

FIGURE 27.—Quantities of principal agricultural exports, index numbers, 1909–10 to 1913–14=100 (3-year moving averages).

Source: Derived from *Agricultural Statistics, 1938* (U. S. Department of Agriculture), p. 385.

employment. The decline in cotton exports from the late 1920's to 1937–38 meant a decrease in labor requirements equivalent to approximately 300,000 man-years.

To be more exact, the amount of farm employment in the South would eventually have to be reduced by this amount if foreign demand stayed at its recent levels and if there were no offsetting increases in demand for cotton in this country. Actually, the cotton programs of the Agricultural Adjustment Administration have delayed the full impact of this decline in the export trade to some extent, partly by holding surplus cotton off the market for the present, and partly by accomplishing a more even reduction in cotton production over the whole South, rather than permitting sharply lower prices either to force farmers out of cotton production entirely in disadvantaged areas or to bring all cotton growers to a starvation level of returns.

The second most important farm export has been tobacco, which has come largely from the middle eastern and eastern cotton areas. Labor required to produce exported tobacco increased from approximately 136 million man-hours, or 50,000 man-years annually in the pre-war period to 185 million man-hours during the latter 1920's, an increase of 17,000 or 18,000 man-years. The subsequent decline to 1937–38 was equal to about 10,000 man-years.

The third most important agricultural export consists of hog products, particularly lard. When estimated amounts of time required to care for the hogs and to grow grain to feed them are added together, exported hog products are found to require about 92 million man-hours annually during the pre-war period as compared to 178 million man-hours during 1917–21.

The corn area also exported corn in the form of grain which required about 15 million man-hours a year to produce during 1909–13, and 37 million during 1917–21. Later corn exports fell off until there were actually small imports in 1932–36. This import balance was caused by drought in the United States and did not represent either a proportionate or a permanent reduction in labor.

Increased exports of corn and hog products between 1909–13 and 1917–21 were equivalent to about 35,000 man-years of farm employment in the corn area when counted at 3,000 man-hours per year. This is about one-fourth as great as the decline caused during the same years by reduced exports from the South.[15]

Actually farm employment decreased in the corn area instead of expanding during the war years, because many farms were in a position to adopt tractors and other labor-saving equipment at the time. The increased export demand for hogs and corn, however, helped maintain employment at a higher level than would otherwise have been the case. As Europe became more self-sufficient after the war, hog and corn exports fell until they required about 40,000 fewer man-years in 1932–36 than a decade before.

The exportation of wheat followed trends somewhat like those described for pork products. An increase in wheat exports occurred during the war, calling for an added 68 million man-hours of labor, at the rates per bushel of the small-grain area. The decline from

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[15] See WPA N. R. P. Report No. A–8. *Trends in Employment in Agriculture, 1909–36*, by E. E. Shaw and J. A. Hopkins, tables 3, 9, 11, 13, 15, for the total numbers of persons employed annually on farms in these areas.

the war period to 1927–31 amounted to nearly 100 million man-hours, and unfortunately occurred at a time when large acreages in the small-grain area were being shifted from range to wheat. Trade barriers, the AAA wheat programs, and drought reduced the net movement of United States wheat practically to zero during 1932–36.

Fruits comprise one of the few groups of agricultural products which have been exported in increasing amounts, except during the war and the depression. The estimated amount of labor required annually to produce five principal fruits for export declined from 21 million man-hours in the pre-war to 16 million man-hours during the war period. Thereafter, it increased to 47 million in 1927–31. This does not represent the entire increase in labor on fruits for export, however, since (as indicated in table 60) other fruits, on which export data are not available for the earlier years, were also being exported in increasing amounts. These provided an appreciable source of increased employment in California and the northwestern areas.

The 10 agricultural products just discussed provided in all about 2.6 billion man-hours of work in the pre-war period and not far from 2 billion hours annually from 1917 to 1931, taking the country as a whole. From the 1920's to 1937–38 there was a further decline of 800 million man-hours annually. The full impact on employment has not yet been felt, however, since at least a part of the crops raised—particularly cotton—was held off the market during the late 1930's, and annual production has not been reduced by the full amount of the decline in exports.

The decline in export trade in farm products since 1909 does not mean that the output of American agriculture must be reduced to a like extent. The population of the country has grown in the meantime by much more than a compensating amount. It does mean that, except for a brief revival in some farm exports because of the current war, the size of the agricultural enterprise must conform much more closely to domestic demands than heretofore. It also helps explain why it was not necessary for agricultural output and employment of the country to expand as fast as the growth of population. The reduction of trade barriers abroad might ultimately restore a part of the lost trade in farm products. But with large new agricultural areas opened up or developed in other countries since 1920, and with the population of Europe growing less rapidly than a few decades ago, it is highly improbable that there will be anything like a full and lasting recovery of this source of employment.

CHAPTER X. CONCLUSION

Some of the questions raised in chapter I will now be considered. What were the trends of employment in agriculture? How were they related to technological developments? Have the persons living and working on farms benefited from technological improvements? Finally, are there other considerations that would give us some insight into probable trends of agricultural employment in the future?

Chapter II discussed the fact that employment in agriculture in the United States declined about 10 percent from 1909 to 1936 while the population of the country increased more than a third. The greater part of the decline in farm employment occurred during two periods, the war of 1914–18 and the late 1920's. In the earlier period, however, it was chiefly a decline in the number of hired workers, while in the latter period most of the decline was in family workers. A third period of pronounced change occurred during the depression years. At this time the increase in population backed up on the farm, and hired workers were laid off while family workers increased. Part of this change consisted merely in a shift of some farmers' sons from a hired to an unpaid basis during the years of low farm income. Shifts in employment varied between different geographic areas leading to the development of certain "problem areas" which will be discussed a little later.

Technological developments have fluctuated in rate of adoption. During the war mechanization was particularly rapid and capital was generally available for purchase of labor-saving equipment or permanent improvements. During the depression years, on the contrary, farmers were hard hit and made every effort to avoid new capital outlays. Consequently, in this period more progress was made in other forms of technological improvements such as the adoption of superior varieties of crops, while further mechanization waited until the worst of the depression was over.

Undoubtedly the process of mechanization was responsible for the greatest reduction in farm-labor requirements. This was closely associated with adoption of mechanical power, although larger horse-drawn implements also played a part. It was indicated in chapter V that farm tractors, trucks, and automobiles were responsible for a saving of 785 million man-hours annually in field work and in the production and care of horses between 1909 and 1938, while 530 million hours formerly used in production of feed for horses were shifted to other uses. A satisfactory estimate cannot be made of the effect on time spent in farm transportation, particularly since such services have been greatly expanded with the use of the automobile and truck. It is certain that mechanization will continue at a rapid rate for some time and its further effects on employment may be pronounced as it is just getting under way in the South.

Other types of technological changes besides mechanization also affected farm employment. The more important of these have been considered and an effort has been made to appraise their effects. Changes in cultural methods on crops have brought some small shifts in labor requirements. Development of improved crop varieties has changed direct labor requirements little, but has been important in maintaining or raising yields. Either effect means less labor per unit of crop grown. It was shown in chapter VIII that there was a total decline of 1.9 billion man-hours in labor spent on five principal crops from 1909–13 to 1932–36, but this was from a combination of mechanization, changes in cultural methods, some influences of the depression and a shifting of acreage toward areas in which labor requirements are relatively low. The decline from 1909–13 to 1927–31 amounted to about 750 million man-hours.

In the meantime, production of truck crops and of dairy and poultry products increased. Consequently labor used on 15 truck crops rose about 200 million man-hours by 1932–36, and about 1.4 billion man-hours on three major livestock enterprises.

It has also been shown that the output of livestock products, particularly dairy and poultry, has been increased by discoveries and improvements in animal nutrition, animal breeding, and from better control of animal diseases. Here again, the benefit usually comes not from a reduction in amount of labor per animal but rather from a larger output per head without a proportionate increase in labor, and from a smaller requirement of feed crops to fill a given requirement of livestock products.

RECENT TRENDS IN DEMAND AS AFFECTING FARM-EMPLOYMENT PROSPECTS

Have the changes in farm production from technological improvements and economic shifts been equal to the change in population or have they exceeded or fallen short of these growing requirements? This subject was dealt with briefly in chapter IX. It was shown that, in general, the total amount of food used per capita has changed little from decade to decade, but pronounced shifts between types of food are found, The quantity of agricultural exports has also declined. Trends are, however, far from regular and proceed more rapidly at some periods than at others.

During the depression years the previous downward trend in per capita consumption of cereals continued, as well as that of noncitrus fruits. Consumption of livestock products and sugar did not increase as it had done up to that time, and the rise in consumption of vegetables and citrus fruits became smaller. Among textile crops, the per capita amount of cotton available for consumption ran about 28 pounds during the late 1920's (table 61). This was 5 pounds more than in the pre-war years. Yet during 1932–36 the amount available for domestic consumption per capita out of current crops averaged only 19 pounds. With a bumper cotton crop in 1937 an average of 39 pounds per capita was available for 1937–38.

TABLE 61.—*Annual production of selected agricultural commodities and amounts available for consumption, 1909–38*

Item	Unit	1909–13	1917–21	1922–26	1927–31	1932–36	1937–38
U. S. population [1]	Millions	92.0	105.7	113.2	121.4	126.7	129.9
Production:							
Cotton	1,000 bales	13,033	11,217	13,522	14,657	11,747	15,230
Tobacco	Mil. lb	1,109	1,346	1,336	1,466	1,187	1,470
Wheat	Mil. bu	682	828	790	887	617	903
Hogs	Mil. lbs. live weight.	11,947	13,875	15,598	15,966	13,700	13,440
Exports:							
Cotton	1,000 bales	8,603	5,494	7,366	7,648	6,607	4,590
Tobacco	Mil. lb	339	444	436	464	357	395
Wheat	Mil. bu	105	235	178	143	[2] −1	105
Hogs	Mil. lbs. live weight.	1,217	2,470	1,946	1,266	528	206
Production available for domestic consumption:							
Cotton	1,000 bales	4,430	5,723	6,156	7,009	5,140	10,640
Tobacco	Mil. lb	770	902	900	1,002	830	1,075
Wheat	Mil. bu	577	593	612	745	618	798
Hogs	Mil. lbs. live weight.	10,730	11,405	13,652	14,700	13,172	13,234
Milk	Mil. lb	65,894	74,978	86,322	97,497	102,543	105,144
Beef and veal	Bil. lbs. live weight.	13.4	14.2	13.1	12.8	14.4	14.0
Eggs	Bil. eggs	19.9	23.4	27.5	32.9	31.2	37.3
Potatoes	Mil. bu	355	347	357	371	368	381
Available per capita:							
Cotton	Pounds	23	26	26	28	19	39
Tobacco	do	8.4	8.5	8.0	8.3	6.6	8.3
Wheat	do	376	337	324	368	293	369
Hogs	do	117	108	121	121	104	103
Milk	do	716	709	763	803	809	809
Beef	do	146	134	116	105	114	107
Eggs	Number	216	221	243	271	247	287
Potatoes	Pounds	232	197	189	183	174	176

[1] Population figures given under 1909–13 and 1917–21 are from ch. I, table 1, and represent 1910 and 1920. Data for other periods from Bureau of the Census, and represent averages of annual July 1 estimates.
[2] Import.

Changes in amounts of farm produce exported from our annual production of four key crops, as shown in figure 27, have been fully as important as changes in per capita consumption in the United States. Exports of cotton, tobacco, and hog products have declined sharply, while net exports of wheat disappeared entirely for the period 1932–36. It was shown in chapter IX that the decline in exports of principal farm products since the late 1920's amounted to about 500 million man-hours per year, equivalent to something like 200,000 man-years of employment.

Per capita supplies of cotton, wheat, and tobacco available for domestic consumption have been increased lately, chiefly because of the shrinking exports. On the other hand the increase in per capita supply of milk, eggs, and vegetables during the last two decades comes from a rapid increase in total production. It should be kept in mind, however, that the total population of the country has increased some 9 or 10 million persons since the depression began in 1929, so that domestic production should have risen about 8 percent to provide food and clothing at the previous rate per capita.

Of the 500 million hours of agricultural employment lost because of the reduced export trade, it does not seem probable (in 1940) that

any great part will be recovered in the near future. Not only have the governments in the importing countries attempted to develop ways of getting along without purchases from abroad but, also, population of the European importing countries is increasing less rapidly than in the past. New agricultural producing areas have been developed in various countries and these will offer additional competition for what export market is left. Nevertheless, it is probable that at least a part of this trade may be recovered after the restoration of more normal conditions.

A better opportunity of restoring agricultural employment is likely to be found at home. Restoration of more normal economic conditions in the United States would call for a greater output of food and textile crops, if the rate of consumption in the 1920's is taken as a criterion. Any increase in consumption of total nutritive content of food per capita is likely to be pretty narrowly limited. An important change affecting employment is in the shift toward foods which are of higher quality or palatability and which require more labor per unit of food. The continued growth of population, even though less rapid than formerly, also will increase the demand for farm products slightly from year to year.

PROSPECTS FOR FARM EMPLOYMENT AFFECTED BY BUSINESS ACTIVITY

As the volume of farm employment is affected by the level of business activity as well as by the size of population and rate of its growth, the outlook for farm employment should be considered under two distinctly different sets of general business conditions. Prospects for employment in agriculture under a continued business depression and outlook after the return of a substantial recovery will be discussed.

Prospects During Continued Depression

As long as seriously depressed business conditions continue in urban industries, migration from farm to city is sure to remain at levels too low to remove from farms the number of workers who heretofore have migrated towards city employment. Most of the excess workers remaining on farms will be members of the families of farm operators. This means that hired workers will continue to be displaced from farms while their place is taken by family workers.

Presence of an excessive number of workers on farms may be expected to stimulate intensive types of production, particularly in enterprises which do not require much capital, such as vegetable and poultry production, and to increase the number of part-time or subsistence farms. It may also be expected to cause the retention of relatively laborious farm methods. To the extent that this intensification results in a greater output of farm products it has a depressing influence on farm prices and affects the income of all farm operators. Low income, because of this and other reasons, tends to force farm operators and members of their families to continue to

work long hours in order to obtain the largest possible returns. Low income also tends to delay those farm improvements which require appreciable amounts of new capital and to delay purchases of household conveniences.

The effect of depression on agriculture is greatest in regions with high birth rates and where farm incomes have been lowest in the last few decades; that is, in the eastern mountain, southern, and cut-over regions. Here, high birth rates and low incomes tend to perpetuate each other, and further, needed adjustments in population are large and can be carried out only during periods of rather active nonfarm employment.

It has been indicated that the low income of farm people during depression is partly attributable to low purchasing power of city people, who tend to shift to lower priced types of food which are also low in labor requirements. To some extent food purchases, particularly of such things as milk and green vegetables, may be stimulated by a system of lower prices to persons in unemployed or low-income groups. But such means cannot fully restore consumption to normal levels: (1) some counterbalancing reduction may be expected in purchases of staples; (2) it is probable that the means of stimulating food purchases will not reach all the classes that have reduced their consumption during the depression; (3) some of the consumption shortage is in cotton and other products which are used for industrial purposes rather than for direct human consumption.

Prospects After Business Recovery

What changes in farm employment may we reasonably expect after there is a substantial measure of industrial recovery? First, the farm-to-city drift of population is still in progress, and, under present farm technology, a considerable number of workers are not seriously needed in agriculture. It has been pointed out that these persons are now employable in agriculture only at a very low level of income and that they may be expected to shift to nonfarm employment as soon as opportunities arise. Although such persons are to be found in all agricultural sections, they are most numerous in the southern, eastern mountain, and cut-over regions. It is impossible to estimate their number, but it is evidently large, and may amount to 5 percent to 10 percent of the present number of workers in farming, judging by the relative changes in agricultural workers compared to total population in the two periods 1909–29 and 1929–36.

The reestablishment of more normal economic conditions and the development of more competition for labor between agricultural and urban industries would tend to reduce the length of the farm workday. This would offset to some degree the influences making for decline in farm workers. The trend toward shorter working hours, however, is sure to be slow in an industry composed primarily of family units.

Restoration of something like normal business conditions might be expected to improve the economic condition of the farm population more than that of most other classes. Depression affects farm

incomes partly because of the added competition of unemployed who would normally be working in other industries, and partly because of the reduced demands of city people for the farm products of higher quality and higher labor content. Restoration of employment automatically restores purchasing power of farm products and equilibrium between farm and urban incomes.

The growth of population already discussed could lead to a pronounced increase in farm employment only if agricultural technology remained about as it is. If the productivity per hour of man-labor on farms were to continue to increase as during the last quarter century, the added requirements for food and fibers might well be met without any actual increase in the number of persons employed on farms. Therefore, the future rate of technological improvement becomes a question of critical importance. While it is a question that cannot be answered in specific terms, the progress of mechanization in the South, the rapid adoption of hybrid seed corn in the Corn Belt, and other changes in progress suggest that improvement during the next quarter century may well be as rapid as during the one just past.

This discussion may have left the impression that the advance in technology has been relatively uniform and has applied to all farmers. The advance has been extremely uneven. Some groups have profited greatly for a while, while others have made little progress or have actually lost indirectly because of advancement elsewhere. Thus, the reduction in cost of producing grains in the corn and small-grain areas and with resulting lower price, reduced returns from these crops on the small eastern farms which were unable to employ the same labor-saving methods. Extension of cotton growing into the western cotton area increased output and lowered returns to cotton farmers in the older cotton sections, and so on. Trends of employment in agriculture have differed between areas because of expansion or decline in the agricultural enterprise, varying opportunities for adoption of improved methods, particularly of mechanization, differences in earnings of agricultural labor, and because of differing opportunities for employment in other industries. The result has been the development or perpetuation of certain problem areas, while others have remained relatively prosperous.

PROBLEM AREAS IN AGRICULTURE

One of the problem regions in agriculture is the cut-over section of the western dairy area, a section in which the frontier of agriculture was over extended. The population involved is not as large as that in either the middle eastern or the cotton areas which will be discussed below. Although farm earnings here are very low, the difficulty of shifting these persons to more productive areas or industries seems less than in either of the two southern regions. Until this can be accomplished, the problem is to prevent additional families from moving into these marginal or submarginal sections, where they would not be able to support themselves permanently.

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Another type of farm problem prevails in the small-grain area and the dry farming sections of the range area. The difficulty here comes from uncertain rainfall and wide yearly variation in crop yields. Even though the agriculture is of an extremely extensive type, many of the grain farms use the land too intensively, considering the scanty rainfall. As a result, wind erosion and dust storms are excessive in dry years, and adequate financial reserves to carry the farmers through intermittent periods of low income are lacking. Here, again, the solution seems obvious in some respects but is very difficult of actual accomplishment, as any pronounced change in degree of agricultural intensity requires an actual reduction in the number of farmers in the area as well as the prevention of excessive settlement following years of favorable rainfall.

In the middle eastern area aggregate size of the farm enterprise increased slightly between 1909 and 1929 and farm employment declined 14 percent. The small farms in mountainous sections here can be operated only by small-scale methods, with a large input of labor per acre, and very low income per capita. The average for the mountain section, composed of the three States, Kentucky, Tennessee, and West Virginia, was only $199 for 1924–29 and $118 for 1930–35, compared to $393 and $241 for the country as a whole, as shown in table 62. As a consequence, there were relatively large migrations from these sections during the 1920's when employment in other industries was available. Unemployment following 1929, however, sent many of these recent migrants back to the farms to await new opportunities for employment. Conditions were aggravated by the high rate of natural increase as well as by the returning migrants. In the years from 1927 to 1936 figures indicate that farm population in these three States increased by 10 percent. While this section could provide adequate support for a smaller number of farm people, it cannot do so for the present population.

The Cotton Belt contains another problem region. Conditions on small farms here are best exemplified by the data from the eastern cotton area where an average of only 14 acres of crops were handled per worker in 1929 (table 62). Gross income per capita on farms in this area averaged only $191 in 1924–29 and $116 in 1930–35. The natural rate of increase is high and there was a large migration away from the farms during the 1920's.

Amount of employment in agriculture here is high. The eastern cotton area contained 13 percent of the agricultural workers of the country in 1924–29, while the three cotton areas contained 36 percent. Serious problems arise from the fact that, with the type of agriculture followed and the methods necessary in the production of small acreages of cotton, it is not possible to provide what workers in other industries or in other segments of agriculture would regard as an adequate income.

TABLE 62.—*Cropland harvested and gross farm income per capita, by farming areas* [1]

Area	Cropland harvested per worker	Gross income per capita	
	1929	1924–29	1930–35
	Acres	*Dollars*	*Dollars*
United States	32	393	241
Corn	47	542	346
Dairy areas	31	470	307
Eastern	22	494	345
Western	39	452	277
Middle eastern	14	223	137
Eastern mountain	13	199	118
Eastern seaboard	14	247	157
Cotton areas	20	254	142
Eastern	14	191	116
Delta	12	214	116
Western	36	364	198
Other areas	70	724	428
Small grain	115	674	363
Range	41	601	341
Northwestern	34	668	406
California	[2] 20	1,165	872

[1] Derived from data presented in following sources: Land in farms, from *U. S. Census of Agriculture 1935*, vol. 1, table III, pp. XX ff. Gross income data as follows: 1924–28, from *Farm Value, Gross Income, and Cash Income from Farm Production 1924–29. Part V* "General Summary of the Income Estimate" (U. S. Department of Agriculture, Bur. Agr. Econ. mimeo.; October 1930) p. 13 ff. 1929 and 1930, from *Crops and Markets* vol. 10, No. 4 (monthly publication of U. S. Department of Agriculture, April 1933) p. 147, table 1. 1931 and 1932, from *Income from Farm Production in the United States 1933* (Reprint from Crops and Markets; 1934) p. 6. table 10. 1933, from *Crops and Markets* vol. 12, No. 7 (July 1936) p. 276, table 11. 1934 and 1935, from *Income from Farm Production in the United States in 1935* [U. S. Department of Agriculture], Bur. Agr. Econ. mimeo., September 1936, pp. 19–20, table 12. (Employment data from Eldon E. Shaw and John A. Hopkins, *Trends in Employment in Agriculture* WPA N. R. P. Report No. A–8).

[2] Based on total employment figure from census data.

BARRIERS TO INCREASED FARM EMPLOYMENT

In the problem areas just discussed a most difficult question which continually comes to the fore is: What other employment can be found for farm populations unable to earn a satisfactory income? Chapter IX showed that the demand for farm products is inelastic and that any increase of effective employment in the industry may be expected to bring more than proportionate declines in prices of the produce. Farm workers in the problem areas just named are employed in a relatively ineffective manner. Many of them, particularly in the cut-over region and in parts of the middle eastern area, contribute relatively little to the market surpluses which are depressing farm income. This is particularly true of the subsistence type of farm. It cannot be said that such farmers do not contribute at all to the volume of market produce, but rather that they contribute proportionately less than would an equal number of other farmers.

Society is thus faced with the dilemma of whether to allow these disadvantaged groups to suffer under an extremely low standard of living, or to attempt to find more productive employment for them. If the latter were done, it would mean either encouraging them to move into other industries, or attempting to increase their productivity where they are. In the former case, they would add to the number of persons employed only part of the time and dependent

on relief the rest. In the latter, their increased production would add to a supply of farm produce already superabundant.

The same considerations prevent carrying out a policy occasionally proposed of settling unemployed persons on the land since such persons could enter agriculture only under the same disadvantages as the farm population now in the problem areas. Even commercial farmers are, at present, none too prosperous, and any new subsistence farmers would certainly produce at a lower degree of efficiency. Further, insofar as their efficiency could be increased, it would inevitably add to the market surplus and lower returns to all other farmers.

Amount of labor employed in agriculture and earnings of farmers are affected very strongly by the amount and grade of available agricultural land. With private enterprise and with each farmer acting to maximize his own individual income, all land that promises an income greater than the current expenses of operating or exploiting it tends to be utilized. This is particularly true so long as there is a large amount of unemployment. It is probable that very little land will be abandoned while families on farms (even on inferior farms) see no better opportunity elsewhere. Further, during periods of economic depression, sharp declines in prices of farm produce force farmers to work even harder and longer than usual in order to cover their fixed expenses and obtain a living. Land erosion and depletion are thus promoted at the very time when the interest both of agriculture and of the nation calls for relaxing the pace of production.

Because of the central role it plays in agricultural production, land is the factor to which measures of control must be applied either in minimizing damage from temporary maladjustments or in directing long-time agricultural policy. Most of the uses to which farm lands are put are relatively easy to observe and land use is easier to administer than the use of labor or capital on the farms. By encouraging or penalizing certain uses of land it is therefore possible to control, to some degree, the labor intensity of land use. This method has already been used with some success by the Agricultural Adjustment Administration, and may be the key to a workable agricultural policy. The timing of such measures is highly important, particularly as regards the volume of labor employed on farms.

Since the demand for farm products is relatively inelastic, the farm cannot absorb the unemployed during periods of economic stress. The contribution of agriculture to the unemployment problem during such periods is rather that the farms are able to absorb, temporarily, the increase in rural population which would normally migrate to the city. Even during periods of normal business activity there is no reason to expect that agriculture will absorb a greater amount of labor. On the contrary, it has been amply demonstrated in this report that improvement in farm technology provides, instead, a means whereby needed foods and fibers can be produced for some years in the future with a steadily diminishing percentage of our labor force engaged in agriculture.

Far from providing a haven for the unemployed, agriculture should be relieved of part of its present labor force in the problem areas when there is return to something like normal business activity. What is desired is to incorporate the underprivileged and underremunerated in the industrial life of the Nation so that they may

have a reasonably good opportunity to earn as much and to live as well as other groups of workers. Such a transfer of labor from agriculture to other industries, in a smoothly functioning economy (not in one that is paralyzed by serious disequilibria) might be expected to benefit both the persons transferred and those who remain in agriculture.

It should not be assumed, however, that a satisfactory objective would be provided by equal earnings for equal work in agriculture and in urban industries. As population growth is greater in rural than in urban areas, it is still necessary to maintain a flow of population from farm to city, and a differential in earnings appears necessary to do so. Neither should it be concluded that a comprehensive program of relieving rural overpopulation in problem areas should be undertaken at once. There is no point in stimulating the transfer of population from such areas while there are several million persons unemployed in the urban areas to which they would move. Besides, they are largely capable of providing a living for themselves where they are, even though at a very low level.

At most, such a program should be limited to keeping open the avenues that excess rural population will naturally follow when opportunities arise, keeping the populations of problem areas informed of opportunities for employment elsewhere, and providing training that will assist them in fitting themselves into new professions. To go further and bring positive pressure to cause such persons to give up what economic security they now have, would certainly involve a responsibility that no democratic government could well undertake.

WHO HAS BENEFITED FROM TECHNOLOGICAL IMPROVEMENTS?

The question may well be raised, Who has profited from improvements in farm technology? Has it been the farmer or the consumer, or has the lot of either of them been bettered? It is clear that farmers have not profited in the problem areas and that many farmers in other regions have gained little if anything in the form of greater income. Many of the technological improvements, as already pointed out, have led to a greater volume of farm production. Part of this increase has occurred on farms in older sections and part has come from the opening up of new areas of production made possible by new and cheaper mechanical methods. Greater production has meant lower price per unit and this has reduced income to farmers who were not able to modify their methods.

In the areas where improved methods have been applied, many farmers have not adopted them until several years after their neighbors—some because of handicaps beyond their control and others because of inertia. These farmers, obviously, have profited little because prices have usually become adjusted to lower costs from the improved methods by the time they were able to make such improvements. At the other extreme, farmers who have adopted new methods or machines before they were sufficiently developed have also lost rather than gained. Only the group of progressive yet cautious farmers who adopted the new methods shortly after they

became economically as well as technically feasible reaped profits from them. Further, this has lasted only until the new methods were generalized and prices adjusted accordingly.

Benefits of technological improvements to the consumers have been unquestionable. The cheapening of farm produce means that consumers spend less for their food and fibers. Labor and capital saved by improved methods are released for the production of additional goods and services. The extent of the gain is indicated, roughly, by the fact that only one-fourth of the population of the country is needed to produce farm products now as compared to one-third in 1909. This somewhat overstates the change, as some operations have been shifted from the farm to urban areas.

It should be borne in mind that the persons on farms have also gained from this same process, insofar as they are themselves consumers both of farm products and of urban products which have been made more plentiful indirectly through their own increased and cheaper production. It should be remembered, too, that farm consumers have gained from improvements in urban technology in the same way that city dwellers have gained from economies on the farm.

To the improvement of farm technology should be attributed no small share of the increased abundance of goods and services, as well as the increased leisure made possible in recent decades. That this abundance has not been fully enjoyed cannot fairly be laid to the process of technological improvement, but rather to the failure of our economic organization to keep abreast of science and technology.

AGRICULTURAL EMPLOYMENT AND THE GENERAL ECONOMIC BALANCE

Most of this report has been concerned with the history of technological developments and resulting shifts in employment in the single industry, agriculture. Several times, however, it has been pointed out that other industries also have been affected, and that changes in value of farm products from technological improvements have been of consequence to the entire population considered as consumers. Not only is the whole economy of the country involved in such developments, but problems growing out of increased productivity of farm workers are common to many other countries as well, particularly those which are employing extensive methods of farm production. Further, the markets for such farm products as cotton, wheat, and lard are also world-wide, and the number of persons that can be employed in producing them depends to a large extent on demands abroad, and on the condition of international trade. Policies concerned with shifts in farm employment must be formulated with full consideration of the place which agriculture plays in the economy of the Nation, and of the status of agricultural production and trade in the economic world at large.

Thus the problem becomes eventually a question of how to achieve and maintain the most satisfactory general economic balance. This study and others in the series of the National Research Project should be considered as providing certain basic data for use in

formulating this broad policy, and not as merely dealing with problems that are separate and independent ones.

With a given population and a given body of material resources our task is to achieve maximum benefit for the population as a whole. In attaining this end the intangible social capital which we have developed in the form of technology—our way of doing things—is a subtle but most powerful instrument. With a farm population nearly the same as in 1909, with nearly the same amount (though in a slightly different form) of capital, our agriculture is producing food and fibers for a population one-third greater. Further, this has been accomplished without more labor, but rather with 10 percent to 12 percent less. Still, there are serious elements of friction and maladjustment. In spite of the fact that several million persons are unemployed, farm workers put in 3,000 hours a year in some areas. Some groups of farm and of urban people are relatively prosperous; othes are inadequately fed and clothed. While economic activity was at a feverish rate in 1928–29 and in 1937, in 1938 it was at a stalemate, and in 1930–33 in a state near collapse.

An ideal to be aimed at in the economic activity of the country is the utilization of all economic resources, including labor, in the production of useful goods and services. Further, these resources should be so distributed that no industry is making less effective use of a resource than could be made of it in some other industry.

As a further ideal, all our resources and labor should be employed continuously. And, finally, it must be recognized that human satisfactions are the ultimate purpose of acts of production, and that it is possible for production to be carried to such a point that goods and services are bought at too high a price in time and effort. In other words, it is not implied that labor should be used to the point of exhaustion, but that productive effort should be balanced with leisure.

Neither in complete nor continuous utilization of our resources have the ideals set forth been approached. In each of these respects a much greater mobility of resources than we now have would be required to obtain these objectives. In each case the rapidity of technological improvement is closely related to incomplete utilization. Shifts in method are likely to throw laborers or capital goods out of employment and a considerable period usually is required to find reemployment. The wider technological shifts are, and the more often they occur, the greater the proportion of our resources and labor that is likely to be idle.

Not only does this phenomenon, which is familiar as "technological unemployment," result in a direct economic waste but, as the economic structure is organized, there is also a danger that a reduction in employment in one field may lead to maladjustments in other fields, one after another. Partly, this descending spiral comes from a rapid rate of technological advances but also it is associated with the technological level. With the great degree of economic interdependence necessary under a highly advanced technological system, a strong economic impulse of any type must soon make itself felt throughout the entire system.

Insofar as agriculture is concerned, it is fairly clear that the greater part of the steady technological change since 1909 has been beneficial

in the sense of enabling the production of more food and fibers with less effort. The worst that can be said of this progress is that it has been very uneven so that some regions have profited considerably while others have lagged far behind and therefore have either gained nothing or have lost in income. Most of the hardships related to economic change have come indirectly through wider economic fluctuations or "cycles" which are implicit in a more highly organized technological and economic system. That is, the technological changes themselves are generally gradual and continuous while the more serious economic problems of the last 20 years have come from or through economic oscillations.

Technological advance brings a great gain in the potential amount of production and of leisure. It brings also a serious loss in economic security and a tendency for fluctuations to become wider and more destructive. A concomitant of a highly advanced technology is a demand and a desperately felt need for some form of social (that is, political) regulation that will overrule economic mischance to the individual and guarantee continuous employment with at least a minimum remuneration.

Loss of security, however, differs widely from one industry to another. In most urban industries the individual worker risks the loss of employment. In agriculture, the same is true of the hired worker. But to the farm operator (who comprises the greater part of the farm-labor force) the injury during a period of maladjustment comes not from a loss of employment but rather from a sharp drop in remuneration for his work. Nevertheless, he feels the same need for a guarantee of economic security, and in his case this has been answered by the creation of the Agricultural Adjustment Administration, the Farm Security Administration, and several other federal agencies. And although these agencies (and their counterparts in other industries) have been of great benefit, they are not supposed to represent the last word in social control over our economic activity. A protracted period of experimentation and of trial of various methods of control may be anticipated before an altogether satisfactory system is devised.

In the early stages of this development, under democratic institutions, it is to be expected that pressure from the most powerful economic groups may swerve the control devices in their own favor from time to time and may thereby aggravate rather than improve the situation.

Indeed, under our democratic political organization, existing agencies can hardly do otherwise than accede in a pronounced degree to whichever popular pressures are strongest. Such agencies can hardly be expected to take prompt and energetic measures to restore the economic balance when that requires shifting to new uses important blocks of resources or large numbers of workers. Palliative measures are more likely to prove popular than thoroughgoing reorganization, and changes which are likely to prove beneficial are sure to be opposed if they are painful while in progress. It may well be that present experimentation is a stage through which it is necessary to pass in developing a system of social control that will both assure economic security and take advantage of the great benefits potentially to be found in technological progress—and yet do this without violating political freedom.

APPENDIX [1]

CHANGES IN LABOR EFFICIENCY IN AGRICULTURE COMPARED WITH OTHER INDUSTRIES

How have the trends of labor efficiency in agriculture compared with those in other industries? Shifts in employment between industries are affected by their relative changes in efficiency as well as by influences affecting each one individually. We are concerned with the relative increase in agricultural labor efficiency as well as with absolute improvement.

Changes in Labor Efficiency in Agriculture

Production per hour of work on the farm products considered in chapter VIII increased from 1909–13 to 1932–36 by amounts varying from 8 percent on dairy products to 116 percent on wheat. Most of this increase in efficiency has occurred since 1917–21. Increases in output per hour of labor on individual crops generally exceed the increase for the farm as a whole. As explained in chapter VIII, there is considerable work on a farm of a general overhead type which cannot easily be reduced. Furthermore, the farmer generally feels a greater incentive to work out and adopt labor-saving changes on his crops, which have pronounced seasonal labor peaks, than on general farm-maintenance work which can be shifted more easily from week to week.

Changes in the over-all efficiency of farm labor are shown in table 63 by 5-year periods. For the United States as a whole an average worker in agriculture produced about 28 percent more in 1927–31 than in 1909–13. For the period 1932–36, however, production per worker was down 8 percent from 1927–31 largely because of droughts. Labor efficiency was also reduced during 1931–36 by the backing up of population on farms so that there were more workers in some regions, such as the middle eastern area, than were really needed. Good crops in 1937 and 1938 brought total production and production per worker up to record levels, demonstrating the strong influence of weather variations on farm production and suggesting, at the same time, that the trend in production per worker is still upward.

In the corn area, in spite of drought and the AAA, production per worker was higher in 1932–36 than in 1927–31 and the total increase in labor efficiency since 1909–13 amounted to 31 percent. The increase was slightly less than this in the eastern, and slightly more in the western dairy area.

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[1] Four appendixes to this volume, typewritten and bound together, are on file in the library of the Bureau of Agricultural Economics where they are readily available to students and others seeking further data. Those appendixes are designated A, B, C, and E. This appendix includes material that would have been designated as appendixes D and F.

TABLE 63.—*Indices of total production and employment in agriculture by areas, specified periods 1909–36*

[1924–29=100]

Area	1909–13	1917–21	1922–26	1927–31	1932–36	1937–38[1]
Total production[2]						
United States	86	90	96	102	93	110
Corn	94	98	101	101	99	128
Eastern dairy	104	105	103	98	100	112
Western dairy	76	87	98	101	100	114
Middle eastern	92	101	101	99	94	108
Eastern cotton	123	114	93	105	97	113
Delta cotton	83	85	91	101	95	130
Western cotton	79	79	93	99	82	94
Small grain	72	83	94	104	78	75
Range	60	83	91	107	93	110
Northwestern	59	80	93	108	112	122
California	58	74	89	113	121	----
Total employment[3]						
United States	106	100	101	99	97	95
Corn	116	107	102	97	93	94
Eastern dairy	127	109	104	96	95	96
Western dairy	99	97	100	98	97	96
Middle eastern	112	104	102	98	101	101
Eastern cotton	119	110	104	98	96	88
Delta cotton	101	93	97	100	100	98
Western cotton	97	94	99	100	92	83
Small grain	100	96	98	100	94	92
Range	86	94	99	102	105	105
Northwestern	86	94	99	101	106	111
California	77	89	93	105	101	----
Output per worker in agriculture (1924–29=100)[4]						
United States	81	90	97	104	96	116
Corn	81	92	97	104	106	136
Eastern dairy	81	97	99	102	104	116
Western dairy	77	91	98	103	104	118
Middle eastern	82	97	99	101	93	108
Eastern cotton	103	103	89	108	102	128
Delta cotton	82	91	93	101	95	132
Western cotton	82	84	92	99	89	105
Small grain	72	86	96	104	82	82
Range	70	89	92	105	89	104
Northwestern	68	85	93	106	106	111
California	75	84	96	108	119	----

[1] Indices of Production for 1937–38 computed in the Bureau of Agricultural Economics.

[2] From Raymond G. Bressler, Jr., and John A. Hopkins, *Trends in Size and Production of the Aggregate Farm Enterprise, 1909–36* (WPA N. R. P. Report No. A–6, July 1938), tables 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, and 48.

[3] From Eldon E. Shaw and John A. Hopkins, *Trends in Employment in Agriculture, 1909–36* (WPA N. R. P. Report No. A–8, November 1938), tables 1, 3, 5, 7, 9, 11, 13,15, 17, 19, 21, and 23.

[4] Employment for 1937–38 from the then Division of Crop and Livestock Estimates, U. S. Department of Agriculture. Obtained by dividing total production by total employment.

In the middle eastern area the most rapid increase in labor efficiency occurred between 1909–13 and 1917–21 when a large number of workers of relatively low productivity were drawn away from farms and into war industries or into the army. From this time until the "back to the farm" movement of the early 1930's further changes in labor efficiency in this area were small.

In the eastern cotton area, output per worker declined about 14 percent during the early 1920's, when the boll weevil cut the yield of cotton. Following this, in the late 1920's labor efficiency was raised rather sharply by two dissimilar influences. One of these was the development of methods of cotton production that minimized losses from the weevil and the other was the movement of farm workers into other industries.

Agriculture in the delta and the western cotton areas from 1909 to the late 1920's was adopting mechanical equipment of greater capacity. Average output per worker rose about 20 percent. With the coming of the droughts and the AAA, however, a third to a half of this gain was lost, at least temporarily. The small-grain area was also a developing region and went further in mechanization than the areas to the east. Production per worker rose over 40 percent from the pre-war years to 1927–31. Similar influences brought large increases in labor efficiency to the range, the northwestern area, and California.

The most common and widespread influence in labor efficiency came from mechanization. Changes in yields from drought, varietal improvement, or favorable years have also played a part. So have the movements of population either toward or away from farms, the opening up of new agricultural areas, and the programs of the AAA. The chief tendency has been toward greater efficiency. A really notable achievement is shown by the increase in production for agriculture per worker which amounted to 28 percent from pre-war years to 1927–31 or 43 percent to the bumper crop years of 1937–38.

In agriculture, animals and to a considerable degree even growing plants may require individual attention. Farm work cannot be reduced to a routine to the same extent as that in a factory or a mine. Area required for production of a crop is so great that farm workers cannot be employed and directed in large gangs. Further, relatively few farm operations can be made automatic. Therefore, the increase in labor efficiency or in output per man-hour in agriculture is less than in many manufacturing industries. Let us examine the changes that have occurred in the latter group.

Trends in Labor Efficiency in Nonagricultural Industries [2]

Manufacturing, and to a considerable extent mining operations, can be reduced to a series of relatively simple routines. Carried a step further, this may lead to the development of automatic processes which require little more than the tending of machinery plus necessary repairing and upkeep. Mechanical power takes the place of muscular effort, and automatic control devices may not only replace direct human oversight, but may, and in many modern cases actually do, result in more uniform and superior quality of product with less wear and tear on equipment.

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[2] For more complete discussion of these trends the reader is referred to the reports of the National Research Project on Manufacture, Mining, and Labor Market, particularly to Harry Magdoff and others, WPA N. R. P. Report No. S–1, *Production, Employment, and Productivity in 59 Manufacturing Industries, 1919–36*, May 1939.

Among the outstanding trends among manufacturing industries in recent decades may be mentioned:

(1) Increased mechanization, and the use of more mechanical power.

(2) Improvements in both chemical and mechanical methods.

(3) Development of industrial plants capable of taking fuller advantage of larger capacity machinery and superior methods.

(4) Concentration of production in the more favorably located plants.

(5) Improved plant organization and management of labor.

(6) Reduced working hours per day.

(7) Organized industrial research, which has speeded the developments just mentioned and which is causing continued improvement.

Trends in Industrial Labor Efficiency

Of the 25 industrial groups shown in table 64, 6 experienced increases in output per man-hour of over 100 percent between the years 1919–21 and 1932–36. In 11 groups, output per hour increased from 50 percent to 99 percent, and in the remaining 8, from 15 percent to 49 percent.

By way of comparison, we find that only wheat, among the individual farm crops which were studied, showed a doubling of production per man-hour from 1917–21 to 1934–36, while oats was next with an increase of between 55 percent and 60 percent. Among agricultural regions, only the small-grain, northwestern, and California areas showed increases in over-all output per worker as great as 20 percent between 1917–21 and 1932–36 (omitting drought years).

It is hazardous to generalize about changes in labor efficiency and production for groups of industries. Each industry operates under a set of conditions which is more-or-less unique. The age of the industry and the stage of its development are of importance in determining the facility with which it accepts innovations. Nature of the product, source of raw materials, amount of skill required of workers, amount of specialized capital equipment already installed, and traditions both of the industry and of its market may affect types and rates of change.

Young industries, such as the rayon, motor vehicle, and chemical industries, which have been improving their organization and expanding in output at the same time, are particularly fertile fields for improvement in efficiency. On the other hand, older industries such as the textile, lumber, and meat-packing industries, which have produced standardized products by long-established methods, are less likely to change rapidly. Indeed the existing methods in these may be more nearly perfected and may contain less opportunity for improvement. Nevertheless, even these old, established, and sometimes stagnant industries are not immune to change. Thus, the glass industry has doubled its output per man-hour because of improved and automatic methods during the past two decades, and the leather industry has undergone rapid change within the last few years.

At first glance it might seem that the conditions peculiar to each individual industry are of such great importance that no generalizations could be made regarding their development and improvement. Nevertheless, many processes affect whole groups of industries. An improvement in one industry may suggest a similar change in another. Improvements in organization or labor management in one type of plant are sure to be copied in or adapted to others. Many mechanical appliances and processes are used over pretty much the whole industrial field. Thus, increased efficiency in the generation and transmission of power has been beneficial to most, if not all, industries in recent decades. Improved antifriction bearings have been of wide benefit. Particularly important have been the development and adoption of auxiliary instruments for indicating, recording, and controlling processes. These may be used to control temperature, humidity, pressure, or the rate of combustion, of flow, or of chemical processes.

The industrial groups for which data are shown in tables 64 and 65 are divided into three groups on their rates of increases in output per man-hour. In the group showing the greatest increase, the median output per man-hour more than doubled between the 1919–21 period and 1932–36. In the middle group the increase was approximately two-thirds, and in the group with the least improvement it was slightly less than a third. Of the 25 industries shown, all except 1 increased their output per man-hour between 1927–31 and the depression period 1932–36. In the two groups with the greatest improvement in labor efficiency the increase became smaller from period to period. Obviously, these industries do not afford a basis for forecasting any continuous decline in the rate of change in output per worker for industry in general.

The change in output per wage earner, roughly paralleled changes in output per man-hour. Up to 1927–31 increases per wage earner were slightly smaller than those per man-hour because of the gradual reduction in number of hours worked per week. After 1927–31, the output per wage earner declined in each of the three groups, in spite of the continued and substantial increase in production per man-hour. The explanation is found largely in the tendency to distribute available work among as many persons as possible during the depression.

Total production of the three groups of industries also changed more or less parallel to the trends in output per man-hour, as may be seen from table 65. In the group of industries with the greatest increase in labor efficiency, total production rose 84 percent between 1919–21 and 1927–31. In the second group production increased 44 percent, while in the third group it rose only 6 percent. Changes making for greater labor efficiency are easier to adopt in expanding industries. Nevertheless, increased efficiency, when that results in lower prices, also leads to increases in the subsequent volume of production.

TABLE 64.—*Output per man-hour and per worker in selected industrial groups, 1919–36*

[1924–29 = 100]

Industrial groups	Indices of output per man-hour				Indices of output per wage earner			
	1919–21	1922–26	1927–31	1932–36	1919–21	1922–26	1927–31	1932–36
Greatest increases								
Petroleum refining	[1] 55	[2] 89	109	146	[1] 55	88	107	109
Rayon	-------	[2] 92	122	218	-------	[2] 94	113	173
Silk and rayon goods	62	88	115	154	59	87	114	[3] 122
Glass	66	92	109	148	66	91	104	107
Motor vehicles	60	87	114	126	58	88	106	95
Chemicals	68	83	119	138	68	85	113	108
Paper and pulp	68	90	110	126	72	90	108	105
Cement	72	91	114	133	74	87	110	92
Group median	66	90	114	142	66	88	109	106
Medium increases								
Tobacco products	79	91	110	142	79	91	108	107
Iron and steel	66	89	107	117	75	91	101	76
Canning and preserving	[1] 76	[2] 99	106	[4] 136	[1] 77	[2] 100	100	[4] 94
Electric light and power	[5] 77	97	101	134	[5] 78	96	103	120
Knit goods [6]	82	95	108	144	83	93	106	113
Newspapers and periodicals	67	90	103	115	66	90	103	97
Fertilizer	71	90	109	121	72	90	105	93
Leather	77	95	105	125	78	97	103	105
Flour and grain milling	73	90	112	118	74	91	112	102
Group median	76	91	107	125	77	91	103	102
Smallest increases								
Furniture	74	91	104	106	74	92	98	83
Boots and shoes	92	92	107	131	92	92	105	112
Agricultural implements	[7] 75	85	103	[8] 105	[7] 67	85	96	[8] 85
Meat packing	81	98	103	109	77	97	103	94
Cotton goods	91	100	101	122	88	97	101	99
Woolen and worsted goods	91	96	101	120	91	98	99	99
Clay products (except pottery)	84	94	105	98	84	96	97	74
Lumber and timber	103	94	107	118	93	93	101	90
Group median	87	94	103	114	86	94	100	92

[1] Data not available for 1920.
[2] Data not available for 1922.
[3] Data not available for 1932 or 1936.
[4] Data not available for 1936.
[5] 1917 only.
[6] Data available only for odd-numbered years.
[7] Data not available for 1919.
[8] Data not available for 1932 or 1934.

Source: Based on indices developed by Harry Magdoff and published in *Production Employment and Productivity in 59 Manufacturing Industries* (WPA N. R. P., Report No. S–1, pt. II, May 1939).

TABLE 65.—*Production and employment in selected industrial groups, 1919–36*

[1924–29=100]

Industrial groups	Indices of total production				Indices of employment			
	1919–21	1922–26	1927–31	1932–36	1919–21	1922–26	1927–31	1932–36
Greatest increases								
Petroleum refining	50	79	112	114	[1] 87	[2] 95	106	105
Rayon	16	58	157	315	-------	[2] 68	139	183
Silk and rayon goods	60	85	109	[3] 104	99	98	96	88
Glass	68	93	95	91	104	102	92	85
Motor vehicles	42	82	96	77	73	93	90	79
Chemicals	65	83	111	114	98	98	99	107
Paper and pulp	68	88	105	100	94	97	98	95
Cement	56	88	97	49	76	100	88	53
Group median	58	84	107	102	94	98	97	92
Medium increases								
Tobacco products [4]	96	98	98	80	120	108	91	75
Iron and steel	70	89	94	66	92	98	92	84
Canning and preserving	[5] 60	[2] 91	107	101	[5] 77	[2] 91	106	111
Electric light and power	[6] 38	76	120	124	[6] 49	79	117	104
Knit goods [7]	71	91	104	118	86	98	98	105
Newspapers and periodicals	61	86	105	93	93	96	103	95
Fertilizers	90	90	102	70	127	101	97	77
Leather	91	102	96	95	120	106	93	90
Flour and grain milling	99	100	98	83	133	110	88	82
Group median	71	91	102	93	93	98	97	90
Smallest increases								
Furniture	56	85	92	54	76	93	92	65
Boots and shoes	90	95	101	107	97	103	96	96
Agricultural implements	[1] 100	74	96	54	[1] 157	88	98	61
Meat packing	87	97	100	94	113	101	97	101
Cotton goods	85	98	92	82	98	100	92	84
Woolen and worsted goods	93	107	88	83	102	109	88	84
Clay products (except pottery)	64	96	82	31	76	100	83	41
Lumber and timber	89	100	81	46	96	108	80	50
Group median	87	96	92	68	98	100	92	74

[1] Data not available for 1919.
[2] Data not available for 1922.
[3] Data not available for 1934 or 1936.
[4] Production indices weighted by employment in respective subgroups.
[5] Data not available for 1920.
[6] 1917 only.
[7] Data available or used for odd-numbered years only.

Source: See table 64.

In 1929, production in manufacturing industries was nearly a half again as great as in 1919, while employment was only 2 percent less. The rather widely held belief that increases in output per man-hour generally cause declines in employment in the affected industries receives no support from these figures. In each of the three groups of industries shown in tables 64 and 65 are examples both of increases and of decreases in total employment. Median changes in employment were about the same for each group from 1919–21 to 1922–26. By 1927–31 employment showed a general tendency to decline. By 1932–36, however, the decline in employment amounted to 24 percent in the group with the least improvement as against 6 percent to 9 percent in the groups with the greater improvements.

Comparison of Agricultural and Industrial Trends

Comparison of changes in labor efficiency and production between agriculture and other industries is rendered difficult by the dissimilar influences under which the industries operate. Thus, from 1917–21 to 1927–31, production in agriculture for the country as a whole increased about 13 percent as may be seen in table 63. For the 25 industries shown in table 64 the median increase was over 3 times this amount. During the next 5 years the decline did not differ greatly between agriculture and other industries, but in agriculture this decline was caused chiefly by drought, the programs of the AAA, and depression, while in nonagricultural industries it was associated almost entirely with depression.

In employment the changes in 5-year averages both in agriculture and in nonagricultural industries were small from the end of the war to the beginning of the depression, even though there were some wide shifts between individual industries and between agricultural areas. Between 1927–31 and 1932–36 employment in agriculture declined only about 2 percent, while, among nonagricultural industries, there was a decline of 5 percent in those with the greatest, and of nearly 20 percent in those with the smallest improvements in labor efficiency. The divergence in trend of employment is largely explained by the fact that unneeded workers in nonagricultural industries were laid off or employed part-time, while in agriculture such curtailment was impossible because of the large proportion of self-employment, the reduced migration from the farm, and the return to farms of unemployed workers from the cities.

Additional material, deposited in typewritten form in the Library of the Bureau of Agricultural Economics, includes: Note on Estimation of Population Dependent on Agricultural Employment; Total Capital Investment and Investment per Farm; Changes in Farm Organization in a Selected Group of Farms; and Elasticity of Demand for Farm Products.

LABOR DATA ON AGRICULTURAL EXPORTS

TABLE 66.—*Estimates of farm labor used per unit of exports, hours per unit,*[1] *by specified periods, 1909–38*

Item	Unit	1909–13	1917–21	1922–26	1927–31	1932–38
		Hours	*Hours*	*Hours*	*Hours*	*Hours*
Cotton [2]	Bale	259	253	235	217	202
Tobacco [3]	Pound	0.4	0.4	0.4	0.4	0.4
Hog products [4]	100 pounds, live	2.5	2.5	2.5	2.5	2.5
Wheat [5]	Bushel	.78	.64	.50	.37	.31
Corn [6]	do	.57	.54	.53	.52	.49
Apples [7]	do	.8	.8	.8	.8	.8
Prunes [8]	Ton, dried	105	105	105	105	105
Raisins [9]	do	100	100	100	100	100
Apricots, dried [9]	do	200	200	200	200	200
Oranges [9]	Box	.7	.7	.7	.7	.7
Grapes [9]	Ton		40	40	40	40
Peaches [9]	Bushel		.7	.7	.7	.7
Pears [9]	do			1.3	1.3	1.3
Apricots, canned [9]	1,000 pounds			20	20	20
Grapefruit [10]	Box			.8	.8	.8

[1] Estimates are approximate only and where changes in labor requirements seemed to be small or where inadequate data were available for varying the estimates between periods, it will be noted that the same number of hours was used for each period.

[2] Hours per bale derived from WPA N. R. P. Report No. A-7, table 29, p. 103. Two-thirds of the cotton exported was taken at the rate prevailing in the respective periods in the western cotton area and one-third at that for the delta area, except for 1909–13. For this period the entire crops of these areas were less than amounts exported; consequently, half of the exports were counted at the rate per bale in western cotton area, and a quarter each at rates of the delta and eastern cotton areas. Hours per bale for cotton exported in 1922–26 were taken as midway between the 1917–21 and the 1927–31 requirements.

[3] From WPA N. R. P. Report No. A-6, *Trends in Size and Production of the Aggregate Farm Enterprise, 1909–36*, by R. G. Bressler, Jr., and John A. Hopkins, p. 245, labor requirement on tobacco for middle eastern and eastern cotton areas.

[4] Estimated from various agricultural experiment station publications for the corn area.

[5] From WPA N. R. P. Report No. A-10, table 24. Hours per bushel for 1922–26 were taken as halfway between the requirements for 1917–21 and 1927–31.

[6] From WPA N. R. P. Report No. A-5, table 44, p. 120. It was assumed that corn exported came from the corn area. Hours per bushel for 1922–26 were taken as halfway between the 1917–21 and 1927–31 requirements.

[7] Estimated from various agricultural experiment stations and U. S. Dept. of Agr. publications, particularly New York, Cornell Bul. 565, pp. 26, 64–67, New York, Cornell, Ext. Bul. 395, pp. 26, 27; Washington, Bul. 239, pp. 65, 66; U. S. Department of Agriculture Dept. Bul. 446, pp. 9, 24, 26, 32.

[8] Estimate based on Oregon Agr. Expt. Sta. Bul. 292, pp. 54, 58, 91.

[9] Estimate based on number 9-hour days per acre, in WPA N. R. P. Report No. A-8, pp. 134–135, with the following yields per acre, partly from Calif. Agr. Expt. Sta. Bul. 623, *Seasonal Labor Requirements for California Crops*, by R. L. Adams, table 1, p. 6, and partly on correspondence with persons in Agricultural Economics Department, Univ. of California.

[10] From WPA N. R. P. Report No. A-6, table C-3, p. 246.

TABLE 67.—*Approximate numbers of hours spent in producing principal fruits for export, by specified periods, 1909–38* [1]

Fruit	1911–13	1917–21	1922–26	1927–31	1932–36	1937–38
	1,000 hours	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*	*1,000 hours*
Apples	[2] 11,746	[3] 6,046	15,669	21,267	16,014	12,510
Prunes	4,587	3,916	7,501	12,777	9,655	11,550
Raisins	1,047	3,001	5,603	7,909	5,217	7,300
Apricots, dried	2,600	1,600	2,000	2,600	2,800	3,200
Oranges	891	1,203	1,812	2,570	2,618	4,686
Total, 5 fruits	20,871	15,766	32,585	47,123	36,304	39,246
Grapes		[4] 366	198	779	512	1,168
Peaches		[3] 581	1,688	2,035	1,722	1,837
Total, grapes and peaches		947	1,886	2,814	2,234	3,005
Pears			3,147	4,818	6,249	6,504
Apricots, canned			620	520	420	600
Grapefruit			189	723	663	872
Total, pears, canned apricots, grapefruit			3,956	6,061	7,332	7,976

[1] Total hours for exports of each specified product, computed by multiplying quantities exported by estimated hours per unit.

[2] July 1912–June 1914, fresh and dried apples only. [3] July 1919–June 1922.

[4] Labor equivalent on net imports deducted in arriving at total.

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